From: Eric Wedemeyer [mailto:ewedemeyer@co.shasta.ca.us]
Sent: Thursday, November 07, 2013 1:07 PM
To: Moeller, Lewis@DWR
Subject: FW: Sacramento River Regional Report for Ca Water Plan

Mr. Moeller-

Reviewed and annotated the attached regional report. Hope it helps make a better product.

/Eric

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Report Details — Public Review Draft

Writers or volume leads, please provide context and input to the publications staff in the space below. [Notes from editors to staff will be in comments or in gray highlighting and editor's brackets.]	
Region	*Sacramento River Hydrologic Region*
Contact person	*Michael Ward (530) 529-7378 ward@water.ca.goc*
Notes to editor	*Type any notes to the editor here (i.e., to mention any information currently missing or to confirm any unusual spellings/facts that may generate queries from the editor otherwise).*
Design/graphics information	*Type any notes about the status of graphics, or any suggestions about photos/figures, here.*
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Table information	*Please list corresponding tables and their status here.* ***SR-1 NSF Recovery Priorities for Selected Water Bodies in Sacramento Valley*** *SR-2 Federally Recognized Tribes in Sacramento River Hydrologic Region* *SR-3 Landuse Acreage Estimates* ***SR-4 2001 Estimates of Annual CVP/SWP Water Demand by Region*** *SR-5 Estimates of Annual CVPSWP Water Demand by Region* *SR-6 Summary of Large, Medium, Small, and Very Small Community Drinking Water Systems in the Sacramento River Hydrologic Region* *SR-7 Summary of Small, Medium, and Large Community Drinking Water Systems in the Sacramento River Hydrologic Region that Rely on One or More Contaminated Ground-water Well(s)* *SR-8 Summary of Contaminants Affecting Community Drinking Water Systems in the Sacramento River Hydrologic Region*
Glossary entries	*Type any terms/definitions here that you would like to see included in the glossary. Please ensure they are defined in the text of this report, too.*
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Sacramento River Hydrologic Region

Sacramento River Hydrologic Region Summary

The Sacramento River Hydrologic Region includes the entire California drainage area of the Sacramento River (the state's largest river) and its tributaries. The region extends from Chipps Island in Solano County north to Goose Lake in Modoc County. It is bounded by the Sierra Nevada on the east, the Coast Range on the west, the Cascade and Trinity Mountains on the north, and the Sacramento-San Joaquin Delta (Delta) on the south. The Sacramento River Basin actually begins in Oregon, north of Goose Lake, a near-sink that intercepts the Pit River drainage at the California-Oregon border.

Agriculture is the region's largest industry, contributing a wide variety of crops including rice, grain, tomatoes, field crops, fruits, and nuts. Agricultural acreages are detailed below in the watershed summaries.

In parts of the Sacramento River corridor, continuous tracts of vegetation have been converted to other vegetation types leading to scattered fragments of original habitat. ~~Pre-dam factors~~Factors that have also impacted the Sacramento fishery prior to large scale dam construction include railroad construction in upstream ~~of Shasta Dam~~ of the Sacramento river and its tributaries, drainage from Iron Mountain Mine, and historic gold mining in the Feather and Yuba basins. In the lower Feather River, hydraulic mining impacted its channel and floodplain with up to 20 feet of sediment (Anderson 2012). In the Yuba River, mining debris completely covered salmon spawning beds and floodplain for up to one and one-half miles from the river with sediments five to ten feet in thickness (Yoshiyama et al. 1998 as referenced by Vogel 2011). 1

Water development projects have also altered natural geomorphic river processes resulting in reduced spawning habitat and fragmented riparian systems. Spring-run salmon cannot access most of their historic spawning and rearing habitats above the dams and spawning is now restricted to the mainstem of the Sacramento River and a few tributaries. On the positive side, the dams provide increased flexibility with cold water releases and increased flows during summer months providing conditions more favorable to salmon (Vogel 2011).

In recent years, salmon populations have been a concern to the extent that the Pacific Fisheries Marine Council and the National Marine Fisheries Service (NMFS) closed commercial and most recreational fishing in 2007, 2008, and 2009. At issue in the Central Valley is the potential loss of the genetic diversity that Central Valley Chinook populations lend to the species. This region has the southern-most spawning populations which are at a greater risk of extinction than most coastal populations. Central Valley populations may lend the genetic diversity necessary for the species survival and are therefore considered a high priority for conservation (Zueg et. al. 2011).

In light of these issues, habitat conditions for anadromous fish have significantly improved over that last two decades. Adult fish passage has improved with the removal of major fish barriers, water temperatures have improved downstream of the major dams, discharges from Iron Mountain Mine have been remediated, and major efforts have been undertaken to screen unscreened or inadequately screened water diversions (Vogel 2011). These efforts continue under several federal and State programs focused

Comment [FG1]: It was mentioned that this summary needed to reference agriculture. As well as throughout the document.

This was also an issue/comment that Andrew Aguilar made.

Comment [ljm2]: I brought this from update 2009 and I think there is good coverage of agriculture through all the watershed summaries. In answer to FG1 on species and ecosystem components considered to be at high risk.

PLACEHOLDER Figure SR-1 Sacramento River Hydrologic Region

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Current State of the Region

Setting

Watersheds

The following provides a short description and summary of issues for watersheds (see Figure SR-2) identified by the NMFS as having core populations of salmon and steelhead. These watersheds have the physical and hydrologic features considered necessary for the recovery of these species.

PLACEHOLDER Figure SR-2 Sacramento River Hydrologic Region Watersheds

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Clear Creek Watershed

Clear Creek originates in the mountains east of Clair Engle Reservoir and drains an area of approximately 238 square miles (NMFS 2009). Whiskeytown Dam stores and regulates run-off from the Clear Creek watershed. Flows provided to Clear Creek below Whiskeytown Dam are at least 200 cfs from October through June. During the summer months, flows are maintained to provide adequate water temperatures for holding adult spring-run Chinook salmon and for rearing steelhead (NMFS 2009). Construction of Whiskeytown Dam and gold and gravel mining has reduced suitable spawning gravels and riparian habitat along the lower sections of Clear Creek (NMFS 2009).

Clear Creek is designated critical habitat for spring-run and CV steelhead. Key threats and stressors for creek include:

- Passage barrier at Whiskeytown Dam
- Water temperature and quality
- Habitat alteration and availability of instream gravel
- Flow conditions
- Sedimentation
- Loss of floodplain habitat and natural river morphology

The Clear Creek Floodway Rehabilitation Project, which began in 1998, has been responsible for helping to redefine the creek channel and floodplain, isolate salmon from stranding, and has provided for riparian habitat. The general purpose of the project is to restore steam channels; determine long-term flow needs for spawning, incubation, and rearing; provide flows to meet the requirements of all life stages of Chinook salmon and steelhead trout; provide spawning gravel to replace supplies blocked by Whiskeytown Dam; and monitor the results.

Spawning habitat on Clear Creek is improving with restoration efforts, gravel augmentation, and increased flows for temperature control, often with cold water diverted from the Trinity River. Recent studies on Clear Creek using a gravel size suitable for steelhead have found that steelhead have utilized all newly added injection sites (NMFS 2009b). By the year 2020, the overall goal for spawning gravel supplementation is to provide 347,228 square feet of usable spawning habitat between Whiskeytown Dam and the former McCormick-Saeltzer Dam. The annual spawning gravel supplementation target is 25,000 tons per year but an average of 9,358 tons have been placed annually since 1996 due to funding constraints (USBR 2011d).

CVPIA has provided funding for the design and permitting of projects on BLM and DFG lands to provide a long-term supply of spawning gravel. The projects reduces the threat of mercury contamination through separation and relocation of contaminated materials, and provide an economical 40-year supply of gravel while using renovated mine tailings to restore floodplain and upland habitats (USBR 2011d). The value of potential spawning habitat may be reduced under future operations in critically dry years when cold water releases cannot be maintained from Whiskeytown Dam (i.e., years when Trinity River diversions are reduced).

Comment [ebw3]: Perhaps prior introduction of linkage between Trinity and Whiskeytown are in order.

Under CVPIA 3406(b)(2), interim flows have been increased to 200 cfs from 50 cfs for the period of September through mid-June and to approximately 70 to 90 cfs during the summer for temperature control, often with cold water diverted from the Trinity River. The flow of 200 cfs was based on flow studies conducted in the mid 1980's. FWS has conducted new flow studies for both the lower and upper segments of the creek which are due to be completed in 2011 and 2012. Studies have also been conducted to develop channel maintenance flows to reactivate fluvial geomorphic processes. FWS has set a minimum target pulse flow release of 3,250 cfs from Whiskeytown Dam for one day occurring 3 times during a ten year period between the dates of March 1 and May 15. Results of pulse flows in 2010 suggested that higher flows are needed (USBR 2011b). Other flow actions include pulse flows in May and June to attract spring-run to the higher reaches where cooler water temperatures can be maintained over the summer holding period (NMFS 2009b).

Cottonwood Creek Watershed

The Cottonwood Creek Watershed is the largest tributary to the Sacramento River on the west side of the valley and is an important source of spawning gravel to the upper Sacramento River (CDFG 2011). It~~'s~~ is estimated that the creek supplies almost 85 percent of the coarse sediments and spawning gravel for the Sacramento River between Redding and Red Bluff. As such this creek plays an important role in the recovery of listed species. Changes in the creek since the early 1970's have occurred such as rapid shifts in stream channel alignment, increased bank erosion, and damage to adjacent properties in the lower 15 miles of the creek. The changes appear to be the result of aggregate extraction in excess of annual replenishment rates (Matthews 2003).

Comment [ebw4]: Which stretches of the creek?

Cottonwood Creek itself does not have suitable habitat to support a spring-run Chinook salmon population (NMFS 2009). Viability potential for spring-run Chinook salmon is considered low. Viability for steelhead is considered moderate (NMFS 2009).

Cow Creek Watershed

The Cow Creek watershed is located in eastern Shasta County and encompasses about 430 square miles. The watershed consists of five main tributaries: Little Cow Creek, Oak Run Creek, Clover Creek, Old

Cow Creek, and South Cow Creek.

Irrigation in the watershed consists of a series of diversions and lift-pumps in all tributaries. Water rights in the Cow Creek Watershed are adjudicated and there are approximately 278 recorded diversions. The primary water quality issues in the watershed are related to bacteria, temperature, and erosion/sediment discharge. North Fork Cow, Clover, Oak Run, and South Fork Cow Creeks are all 303(d) listed as impaired waterbodies for bacteria. The watershed provides habitat for fall-run and late fall-run Chinook salmon and steelhead.

The watershed has low viability potential to support spring-run Chinook salmon and moderate viability potential to support a population of steelhead (NMFS 2009). Sections of the watershed do not have suitable habitat and insufficient flows result in warmer water temperatures. Extensive restoration is needed for a population to spring-run Chinook to persist (NMFS 2009). Key stressors to steelhead include passage impediments/barriers, flow conditions, water temperatures, predation, hatchery effects and entrainment at unscreened diversions.

8

Comment [ebw5]: Maybe a more reliable water supply would help. Development of the Cow Creek Project (explored by the Corps of Engineers in the 1970's and 80's) would help

Antelope Creek Watershed

Antelope Creek is considered critical habitat for spring-run Chinook salmon and steelhead. According to the draft NMFS Recovery Plan, Antelope Creek has high potential to support a viable population of steelhead. The creek is characterized as having a moderate potential to support a viable population of spring-run Chinook. The upper reaches of the creek are fairly undeveloped. Issues in the watershed concern impaired stream flows and fish passage on the valley floor below agricultural diversion. The primary focus for restoration is on improving flow conditions and fish passage for upstream migrating adults.

Battle Creek Watershed

The Battle Creek watershed includes the southern slopes of the Latour Buttes, the western slope of Mt. Lassen, and mountains south of the town of Mineral. The watershed drains an area of approximately 360 square miles.

Battle Creek may be the only remaining tributary to the Sacramento River that can sustain breeding populations of steelhead and all four runs of Chinook salmon. The watershed has been identified as having high potential for the recovery of spring-run Chinook salmon due to its relatively high and consistent cold water flow. Battle Creek also has the largest base flow season of any of the tributaries to the Sacramento River between Keswick Dam and the Feather River.

Current restoration actions include the installation of fish ladders and fish screens at three dams. Construction is expected to be completed in 2014. Other restoration actions include the removal of small dams on the South Fork Battle Creek, increasing flows from existing diversions, and hatchery releases. Once restoration actions are completed, 42 miles of additional habitat will be reestablished plus an additional 6 miles of habitat within area tributaries.

Big Chico Creek Watershed

Big Chico Creek begins in Chico Meadows and flows approximately 45 miles to its confluence with the Sacramento River. The creek can be divided into three zones: the upper zone extending from the headwaters to Higgin's Hole, a middle zone extending from Higgin's Hole to Iron Canyon, and the third zone extending from Iron Canyon to the Sacramento River (NMFS 2009).

Mud Creek and Rock Creek join Big Chico Creek about 0.75 miles before it enters the Sacramento River. These creeks provide seasonal flows from about November to June in the valley portions of their channels. An outflow weir at Lindo Channel diverts excess flows from Big Chico Creek through a diversion channel to Sycamore Creek which then flows into Mud Creek (NMFS 2009).

The lowermost 24 miles of Big Chico Creek provide aquatic habitat for anadromous salmonids. The creek provides habitat for adult spring-run Chinook salmon holding and spawning, while Mud, Rock and Sycamore creeks have been shown to be important non-natal rearing areas for salmonids (NMFS 2009).

Bear River Watershed

The Bear River originates on the west side of the Sierra Nevada and flows to the southwest about 65 miles to its confluence with the Feather River. The upstream limit for anadromous fish is the South Sutter Irrigation District's diversion dam. The river contains a large volume of mining sediment stored in its main channel - estimated to be up to 160 million cubic yards (NMFS 2009).

The potential for Bear River to support a viable population of steelhead is considered low. This is due to a limited amount of habitat for spawning and rearing at suitable elevations. Inadequate stream flow prevents the establishment of a self-sustaining steelhead population (NMFS 2009).

Butte Creek Watershed

The Butte Creek watershed originates on the western slope of the Sierra Nevada Mountains and encompasses about 800 square miles. The watershed contains a series of dams, diversions, and canals that are mostly located in the middle and lower canyon portions of Butte Creek. The hydrology of Butte Creek has been extensively modified and developed, contains multiple hydropower diversions, and imports water from other watersheds. Land use within the watershed includes agricultural uses (64%) with rice production being the most dominant crop, forest related uses (13%) with the remaining lands used for commercial, industrial, and residential uses (NMFS 2009).

Restoration actions have included the removal of Western Canal, McPherrin, McGowan, and Point Four Dams, screening modifications or construction on five other diversions, and construction of a canal siphon along Butte Creek to aid fish passage (CDFG 2011).

Butte Creek is considered to have moderate potential to support a viable population of steelhead. Key stressors to spring-run Chinook salmon and steelhead include water temperatures, passage impediments/barriers, flow fluctuations, summer instream recreation, upper watershed conditions and fire risk. Watershed management objectives and recommended actions to achieve the objectives are included in the Butte Creek Watershed Management Strategy (2000).

Mill Creek Watershed

The Mill Creek watershed originates on the southern slopes of Lassen Peak and encompasses about 134 square miles. Mill Creek initially flows though meadows and dense forests before descending through a steep rock canyon to the Sacramento Valley. There are three dams on Mill Creek. Two are operated by the Los Molinos Mutual Water Company and one is operated by the Clough and Owens ranches.

During low flow periods, existing water rights are sufficient to dewater the stream. There are cooperative agreements between resource agencies and water diverters to provide adequate flows for salmon during peak migration/spawning periods. An interagency water exchange agreement is in place which provides pumped groundwater to meet irrigation water needs during critical time periods (sacriver.org).

Mill Creek supports the majority of its original native aquatic species assemblages (NMFS 2009). The main focus for spring-run Chinook salmon restoration is to maintain flow conditions for upstream migrating adults. Mill Creek is considered to have high potential to support a viable independent population with few restoration actions. Threats and stressors identified for spring-run Chinook salmon and steelhead include elevated water temperatures, low stream flows, and risk of catastrophic fire. Concerns about water temperatures apply mainly to the lower reaches of the creek.

Deer Creek Watershed

The watershed originates near the summit of Butt Mountain and drains an area of about 134 square miles. Deer Creek initially flows through meadows and dense forest and then descends through a steep canyon to the Sacramento Valley. Highway 32 runs parallel to Deer Creek in the upper watershed which is a major concern with respect to the possibility of a spill event (sacriver.org).

Deer Creek contains about 40 miles of anadromous fish habitat with approximately 25 miles of adult spawning and holding habitat. The three diversion dams (the Cone-Kimball Diversion, Stanford-Vina Dam, and Deer Creek Irrigation District Dam) present passage impediments to adult steelhead during low flow periods. Water temperatures throughout the watershed are suitable for juvenile steelhead rearing except for summer months when temperatures in the lower watershed are too high (NMFS 2009). The viability potential for spring-run Chinook salmon and steelhead is considered high (NMFS 2009).

Feather River Watershed

The Feather River watershed is part of the northern Sierra Nevada mountain range and is the source of water for Lake Oroville. The USFS manages over 80 percent of the Feather River upper watershed.

The watershed has two general terrains. Divided by the Sierra Crest, the west side of the watershed is made up of steep forested valleys and the east side consists of less steep terrain and broad valley floors. Because of the steep terrain, west side surface streams are less susceptible to degradation from erosion and head cutting. The east side of the watershed is more degraded by the loss of riparian and upland vegetation, deep channel incision, and sediment runoff from forest logging roads.

Meadows are the most sensitive landforms in the watershed. Meadows are remnant lake bottoms with highly erodible soil types that can produce great volumes of sediments. Meadow restoration has been a major component of the restoration efforts in the region. Meadow restoration has reduced erosion, increased aquifer storage, and improved riparian vegetation.

Each of the main stems and tributaries of the Upper Feather River have some degree of degradation. Fish habitat and passage have been impacted by stream channelization to control flooding, sediment deposition resulting from bank erosion and runoff, and loss of riparian vegetation. The goals of the Upper Feather River Integrated Regional Water Management Plan support the rehabilitation of all streams to “functional, ecologically healthy conditions that support aquatic biota” (ESF 2005).

Hydropower in the region includes projects on the North Fork Feather River and Lake Oroville. The Rock Creek-Cresta Project (FERC License 1962) operated by PG&E is located on the North Fork Feather River in Plumas and Butte Counties. In 1991, PG&E and CDFG entered into a Fish and Wildlife Agreement to establish minimum streamflows and other resource management measures for the protection, mitigation, and enhancement of fish and wildlife resources (ESF 2005).

The North Fork Feather River Project 2105 (FERC License 2105) is located in Plumas County. PG&E filed a settlement agreement with the FERC in 2004 as part of relicensing. Under the agreement, PG&E will operate Lake Almanor to specified lake levels and required releases below Canyon Dam. Fish flows in the Belden Reach and Seneca Reach will be increased depending on the month and water year type. PG&E will also release pulse flows in both reaches in certain months during wet or normal years.

There are two reaches of the Feather River where both fall-run and spring-run Chinook spawn: the low-flow channel from Oroville to Thermalito Afterbay outlet, and the lower reach from Thermalito Afterbay outlet to Honcut Creek (Vogel 2011). Approximately 75 percent of the natural fall-run spawn in the eight-mile reach between the Fish Barrier Dam and the Thermalito Afterbay outlet (Vogel 2011). Gravel recruitment is an issue for the low-flow channel of the river. Water temperatures range from 47 F in the winter to 65 F in the summer (Vogel 2011). The summer water temperatures can limit salmon production.

Recovery and restoration actions identified for the Feather River include the development of a hatchery genetic management plan for the Feather River Fish Hatchery, development and implementation of a spring-run pulse flow schedule that is coordinated with Yuba River operations, gravel augmentation, and implement facility modifications to meet water temperature goals (NMFS 2009).

American River Watershed

The American River watershed is part of the Sierra Nevada Mountain range and drains an area of approximately 1,895 square miles (Lee DP and Chilton J 2007). The river accounts for about 15 percent of the Sacramento River flow. The medium historical unimpaired run-off is 2.5 maf, ranging from 0.3 to 6.4 maf.

Folsom Dam is located on the river and impounds the south and north forks of the American River. The dam is part of the CVP. Nimbus Dam and Powerplant are located 6.8 miles downstream of Folsom Dam. Nimbus Dam re-regulates water released from Folsom Dam and diverts water to the Folsom South Canal. Water not diverted to the canal is released to the American River. Both dams are a factor with respect to the restoration potential of the river. Bank erosion, channel degradation, riprap revetments, and reduced amounts of woody debris have all contributed to the decline of riparian vegetation.

The Nimbus Fish Hatchery is located adjacent to the American River approximately 15 miles east of the City of Sacramento. The goal of the hatchery is to mitigate for spawning habitat eliminated by the construction of the Nimbus Dam. Chinook salmon reared at the hatchery are considered part of the Central Valley fall-run.

The river currently provides about 23 miles of riverine habitat to anadromous salmonids. Warm water temperatures in the lower American River during the summer and fall are considered to be the primary stressor to steelhead. Above Folsom Lake, riverine habitat is available in the North, Middle, and South forks of the river; however, the quality of habitat needs to be assessed (NMFS 2009).

The potential for the lower American River to support a viable population of steelhead is considered low. The natural population is considered to be at high risk of extinction because most of the fish population is from the hatchery. The potential for a viable population above the dams is considered moderate for spring-run salmon and steelhead. The reintroduction of spring-run Chinook salmon to the North and Middle forks of the river would represent separate fish populations.

Yuba River Watershed

Yuba River is a tributary of the Feather River and provides about a third of the Feather River flow. The main stem of the river is about 40 miles long and is split between the North, Middle, and South forks. The confluence of the North and Middle forks is considered the beginning of the Yuba River. The North Yuba River extends for about 61 miles and is impounded by New Bullards Reservoir after which in joins the Middle Yuba. New Bullards Bar Dam and Reservoir provides favorable conditions for over-summering spring-run Chinook in the lower Yuba River due to higher colder flows (Vogel 2011).

The Yuba River then flows southwest to Englebright Lake where it is joined by South Yuba. Construction of the Englebright Dam was completed in 1941 to hold back hydraulic mining debris from historic placer mining. The dam is located approximately 24 miles upstream of the Feather River. Prior to construction of dam, steelhead had been observed spawning in the uppermost reaches of the river.

Below Englebright Dam, the river is characterized as having high potential to support a viable population of steelhead. Daguerre Point Dam is located approximately 11.5 miles upstream of the Feather River. The dam was reconstructed in 1965; however, the fish ladders are considered suboptimal.

Flow, water temperature, and habitat conditions are generally suitable to support all life stage requirements. Proposed restoration actions include gravel augmentation below Englebright Dam and improvement of rearing habitat by increasing floodplain habitat availability. Above Englebright Dam, recovery actions include increasing minimum flows; providing passage at Our House, New Bullards Bar, and Log Cabin dams; and assessing the feasibility of passage improvement at natural barriers (NMFS 2009).

Groundwater Aquifers

This section is under development.

Ecosystems

Much of the natural ecosystem left in the Sacramento Region is based around the Sacramento River riparian corridor. The Sacramento River corridor (river channel and floodplain) is composed of several habitat types. The habitats evolve with changes in channel movement, hydrology, and the different stages of plant communities and include riparian forests, shady and bare eroding stream banks, sloughs, side channels, riparian grasslands, large woody debris and snags, and sand and gravel bars.

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Comment [ebw6]: Not sure how true this statement is for mountian/conifer forest ecosys-tems. A citation is in order.

With respect to riparian plant communities, each plant community in the river corridor is a successional community or "stage" which leads to the establishment of the next successional stage, and so on, until a final stage or climax plant community develops. Over time, one plant community replaces another plant community and each serves a variety of wildlife species. The dynamic nature of the river system is the essential component of this diversity. As the course of the river changes and as plant communities evolve, both the species and the composition of plant and wildlife communities change. Geomorphic processes that support this regeneration and habitat diversity include river meander, sediment deposition of spawning gravels and point bars, and gradual accretion of the floodplain. These processes are the focus of several restoration efforts in the corridor.

Sacramento River Conservation Area Forum Handbook estimates that approximately 23,000 acres of riparian habitat and valley oak woodland remain within the corridor which is about 11 percent of the original habitat (SRCAFH, 2003). Over time, water development projects have altered natural geomorphic river processes resulting in a reduction of spawning habitat and fragmentation of riparian systems. With the construction of Shasta Dam, winter flows have lessened and summer flows are higher. Levees have also had a role in the pattern of flooding and sediment deposition along the river which has impacted plant community succession necessary for the natural establishment of riparian habitat. Other tributaries below Shasta Dam are unregulated and still contribute to flood flows necessary to aid in community succession.

There are four distinct reaches of the Sacramento River within the valley from Keswick Dam to Verona. The reaches are defined as follows:

- Keswick to Red Bluff
- Red Bluff to Chico Landing
- Chico Landing to Colusa
- Colusa to Verona

Each of the reaches are distinct from one another due to regional hydrology, geology, flood control measures, and habitat. The reach between Keswick Dam and Red Bluff is relatively confined due to geologic formations. Adjacent riparian vegetation is typically narrow. The floodplain is less than a mile wide and narrows to less than 500 feet in some places (SRCAF 2003). The reach of the river contains the only existing habitat for winter-run Chinook salmon. With the construction of Shasta and Keswick Dams and the elimination of an estimated 187 miles of habitat that were available upstream of the dams, winter-run salmon were reduced from four independent populations to one dependent population (NMFS 2003). Fish habitat was also impacted with the elimination of recruitment spawning gravels which is estimated to be on the order of 100,000 tons per year (Buer 1985). Since 1978, spawning gravel has been periodically replenished in the upper reaches of the river. CVPIA projects have also been implemented to increase the availability of spawning gravel and rearing habitat (CDFG 2011). ~~With construction~~Since completion of the temperature control device at Shasta Dam and increased flows, this reach of river can provide optimal water temperatures. 10

Within the reach between Red Bluff and Chico Landing, the river meanders over a broad alluvial floodplain ranging between 1.5 to 4 miles wide and provides some of the remaining riparian habitat. The river is also constrained in some places by older, more consolidated and erosion-resistant formations. Several tributaries drain surrounding uplands within this reach and the Keswick to Red Bluff reach and contribute to flood flows necessary for riparian forest succession. .

Within the Chico Landing to Colusa reach, setback levees control the release of flood water to adjoining basins through a system of weirs and bypasses. The setback levees allow for river meander creating extensive tracts of riparian vegetation. Stony Creek is the only tributary to the river.

The main channel of the Colusa to Verona reach is tightly leveed with much of the riparian vegetation existing as linear strips along the levees and levee berms. The river is essentially channelized. Most floodwater leaves the main channel through sloughs and weirs.

Flood

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Flooding in the Sacramento River Hydrologic Region is typically slow-rise, flash, or stormwater flooding. In the Sacramento River Hydrologic Region, exposure to a 500-year flood event threatens approximately one in three residents, almost $65 billion of assets (crops, buildings, and public infrastructure), 1.2 million acres of agricultural land, and over 340 sensitive species. Also, almost 95 percent of Sutter County residents, more than 55 percent of Yuba and Yolo County residents, and more than 50 percent of agricultural land region wide are exposed to the 500 year flood event.

Comment [ebw7]: Strike "typically." All that's left are lahars and glacial dam floods.

Early flood history most notably includes the 1861-1862 floods (the "Great Flood"). This flood was remarkable for the exceptionally high stages reached on most streams, repeated large floods, and prolonged and widespread inundation in the Sacramento River Basin. Lower elevations experienced heavy rain, and upper elevations received continuous snowfall. ~~There were reports~~Reports published 12
during this flooding period describing the lower Sacramento River basin as one vast sea of water. Overflow from the American River led to the flooding of the city of Sacramento, causing loss of life and property, while flooding from the Sacramento River enveloped large sections of the lowlands around Colusa, severely damaging ranches and drowning or starving cattle. It was this flood that provided the impetus for raising the levees around the city of Sacramento.

Since 1950, several sizeable floods have inundated portions of the Sacramento River Hydrologic Region. 13
The floods of 1955, 1964, 1967, 1969, 1970, and 1974 were all characterized by extremely large flows, including record flows at some locations. The Sacramento River Flood Control Project and other flood management programs had been implemented, and project levees, dams, reservoirs, and waterways were employed to control much of the flood flows through the Sacramento system. For a complete list of floods in the Sacramento River Hydrologic Region refer to the California's Flood Future Report Attachment C: Flood History of California Technical Memorandum.

Climate

The northernmost area, mainly high desert plateau, is characterized by cold, snowy winters with only moderate rainfall, and hot, dry summers. The mountainous parts in the north and east typically have cold, wet winters with large amounts of snow providing runoff for summer water supplies. The Sacramento Valley floor has mild winters with less precipitation and hot, dry summers. Overall annual precipitation in the region generally increases from south to north and west to east. The snow and rain that fall in this region contribute to the overall water supply for the entire state.

Demographics

Population

The Sacramento River Hydrologic Region had a population of 2,983,156 people ~~in~~according to the 2010 14
census, making it third only to the South Coast and San Francisco Bay Hydrologic Regions in population out of the 10 California hydrologic regions. The three largest cities are Sacramento, Roseville, and

Redding. The region had a growth rate of 3.31 percent between 2006 and 2010 (98,714 people).

Tribal Communities

PLACEHOLDER Table SR-1 Federally Recognized Tribes in Sacramento River Hydrologic Region

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Federal Clean Water Act (CWA) Programs and Tribes

In the Sacramento River Hydrologic Region six federally recognized tribes are eligible for Section 319 program funding to implement approved programs and on-the-ground projects to reduce nonpoint source pollutions problems.

Big Valley Band of Pomo Indians; Cortina Indian Rancheria of Wintun Indians; Middletown Rancheria of Pomo Indians; Pit River Tribe; Redding Rancheria; and Robinson Rancheria of Pomo Indians.

Section 106 of the Clean Water Act allows tribes to address water quality issues by developing monitoring programs, water quality assessment, standards development, planning, and other activities intended to manage reservation water resources. In Sacramento River Hydrologic Region, seven tribes are involved in Section 106 programs and activities: Big Valley Band of Pomo Indians; Cortina Indian Rancheria of Wintun Indians; Elem Indian Colony of Pomo Indians; Middletown Rancheria of Pomo Indians; Redding Rancheria; Robinson Rancheria of Pomo Indians; and Pit River Tribe.

Tribes with two or more grants and consistently good performance may be eligible to apply for a Performance Partnership Grant (PPG). Four tribes have PPGs: Middletown Rancheria of Pomo Indians; Redding Rancheria; Robinson Rancheria of Pomo Indians; and Pit River Tribe.

Disadvantaged Communities

The geographic area of the Sacramento River hydrologic region encompasses all or portions of 20 different counties. Almost all counties have at least one community that qualifies as a disadvantaged community (DAC). DWR defines DACs as communities and neighborhoods (census-designated places) with an annual median household income of less than 80 percent of the statewide average (or incomes less than $48,706). A total of 282 communities are identified within the region of which 155 are defined as DAC’s.

Counties where 50% or more of the communities within the region qualify as disadvantaged include Butte (53%), Colusa (78%), Glenn (80%), Lake (80%), Modoc (88%), Nevada (58%), Plumas (72%), Shasta (68%), Siskiyou (100%), Tehama (67%), and Yuba (64%). Mapping tools to identify disadvantaged communities can be found at http://www.water.ca.gov/irwm/grants/resourceslinks.cfm. The maps and GIS files are derived from the US Census Bureau's American Community Survey (ACS) and are compiled for the 5-year period 2006-2010.

15

Land Use Patterns

Comment [FG8]: Same comment as above.

The Sacramento River Hydrologic Region between 2005 and 2010 supported about 1.95 million acres of irrigated agriculture on average. Approximately 1.58 million acres is irrigated on the valley floor. The surrounding mountain valleys within the region add about 370,000 irrigated acres to the region’s total -

primarily as pasture and alfalfa (see Table SR-2).

PLACEHOLDER Table SR-2 Irrigated Acreage Estimates

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Regional Resource Management Conditions

Water in the Environment

The focus of several federal, state, and local agencies in the region is the restoration of spawning and rearing habitats of the major rivers and tributaries and the recovery of listed species. Winter-run salmon are listed as endangered under the ESA. Spring-run salmon, steelhead, and green sturgeon are listed as threatened. The loss of habitat and the different life cycles of winter-run salmon, spring-run salmon, and steelhead require that available resources are managed to provide the most optimal conditions possible to lessen the possibility of extinction.

One of the key recovery/habitat restoration programs for the Sacramento River Region has been the Anadromous Fish Restoration Program (AFRP). The Anadromous Fish Restoration Program was established in 1992 under the CVPIA and supports protection, restoration, and enhancement of special status species and habitat that are affected by the CVP. The purpose of the program is to determine baseline production estimates for Central Valley Streams for naturally produced Chinook salmon and other anadromous species and to ensure their sustainability at levels not less than twice the average levels attained during the period of 1967 – 1991. The AFRP fish population goals are: fall run Chinook – 750,000, late-fall run Chinook – 68,000, winter run Chinook – 110,000, and spring-run Chinook – 68,000. During the period from 1967 to 1991, the total average annual fish population for all runs of Chinook was approximately 497,054. Since the enactment of AFRP, the total annual fish population for the period 1992 to 2010 was 410,790 – a decrease of almost 90,000 fish. This low population average is partially due to the 2010 fall run returns which totaled 102,735 fish. On the positive side, the watershed doubling goal was exceeded for Clear Creek, Butte Creek, and Battle Creek (USBR 2012). The six species identified for recovery under this program are Chinook salmon, steelhead, striped bass, American shad, white sturgeon and green sturgeon (USBR 2003).

Restoration/recovery projects that have been funded through AFRP include the temperature control device on Shasta Dam, removal of the McCormick-Saeltzer Dam on Clear Creek, spawning gravel replenishment, and most recently, the Red Bluff Diversion Dam Fish Passage Improvement. The Anadromous Fish Screen Program (another CVPIA program) supports the AFRP and has facilitated the screening of 33 priority diversions since 1994. Currently, there are about 750 unscreened diversions (agricultural and M&I) in the Sacramento River system (USBR 2011e).

The CALFED Ecosystem Restoration Program (ERP) is the principal CALFED program designed to restore the ecological health of the Bay-Delta and Central Valley. California Department of Fish and Game (CDFG) is the implementing agency for the State. The ERP and associated plans are discussed in more detail below.

Other planning that address the recovery of listed species is the NMFS Public Draft Recovery Plan for

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Comment [ebw9]: This is a secion on land, but it might be useful to link a quantity of water with these acreages.

Comment [ljm10]: This is all about agriculture so I am fine with this. We will include a nod to agriculture in the introduction but I think the issue here is not enough about other land use. Answ

Comment [FG11]: In a previous draft, it was mentioned that this needed to be updated by Jenni-fer K or Evelyn. However after a quick read, it seems like it makes references to new material as new as 2011-2012.

Comment [ljm12]: Yes, this looks acceptable.

17

Comment [ebw13]: Hmmm. Since resources have been focussed on these species, populations have decreased. A graphical representation that shows a reduced rate of depletion might be in or-der.

salmon and steelhead. The NMFS is required to evaluate factors affecting the species and identify recovery criteria and actions necessary to achieve recovery. The recovery plan, published in 2009, identifies site specific actions necessary for species recovery and provides measurable criteria necessary for delisting the species.

Another legislative mandate is the Instream Flow Studies Delta Reform Act of 2009 which requires the State Water Resources Control Board (SWRCB) to complete instream flow studies for high priority rivers and streams by 2018. The flow studies are intended to be based on what would be needed if fishery protection was the sole purpose for which waters were put to beneficial use.

18

Comment [ebw14]: Site the later section with stream listings or remove paragraph.

Water Supplies

Comment [FG15]: This entire section is straight out of the 2009 Update.

Comment [ljm16]: Seems to be mostly a history and very little that needs to be updated.

PLACEHOLDER Figure SR-3 Sacramento River Regional Inflows and Outflows in 2010

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Surface Supplies

CVP Water Supply

Most of the water delivered by CVP facilities in the Sacramento River Region is for agriculture use. Sacramento and Redding receive part of their water supply from CVP facilities. CVP water is delivered for agriculture and wildlife refuges through the Tehama-Colusa and Corning canals and is supplied from Red Bluff Diversion Dam on the Sacramento River. The canals serve about 160,000 acres of land in Tehama, Glenn, Colusa, and Colusa, and Yolo counties. CVP contractors and water rights settlement users also make direct diversions from the Sacramento River. The supplies listed include, where applicable, both project water and water rights settlement (base supply) water.

19

Comment [ebw17]: What percent of this water is consuptively used? On just one crop? Is the water available for subsequent environmental or municpal use?

Releases from Folsom Reservoir on the American River serve Delta and CVP export needs and also provide supply agencies in the Sacramento metropolitan area.

Supply from Other Federal Water Projects

Monticello Dam in Napa County impounds Putah Creek to form Lake Berryessa, the principal water storage facility of USBR's Solano Project. The project provides urban and agricultural water supply to Solano County (partly in the Sacramento River region and partly in the San Francisco Bay region) and agricultural water supply to the University of California, Davis in Yolo County. Napa County uses about 1 percent of the supply for development around Lake Berryessa.

Orland Project

There are three reservoirs on Stony Creek north of Lake Berryessa. Two of these are East Park (1909) and Stony Gorge (1928) built on upper Stony Creek. Presently, their supply irrigates small acreages of land in Colusa and Glenn counties before becoming part of the water supply in Black Butte Reservoir. About 100 thousand acre-feet is released from Black Butte Reservoir for irrigation in Glenn County.

SWP Water Supply

Lake Davis, Frenchman Lake, and Antelope Lake are on Feather River tributaries in Plumas County and are used primarily for recreation, but also supply water to the City of Portola and local agencies that have water rights agreements with the California Department of Water Resources (DWR). Lake Oroville and

Thermalito Afterbay also supply the region. Local agencies that receive water rights delivered through Thermalito Afterbay include Western Canal Water District, Richvale Irrigation District, Biggs-West Gridley Water District, Butte Water District, and Sutter Extension Water District. Agencies in the region holding long-term contracts for SWP supply are Plumas County Flood Control and Water Conservation District (FCWCD), Butte County, Yuba City, and Solano County Water Agency. SCWA receives its SWP supply from the Delta through the North Bay Aqueduct.

Local Surface Water Supply

Water stored and released from Clear Lake and Indian Valley Reservoir into Cache Creek is diverted by the Yolo County FCWCD for irrigation in Yolo County. Since 1950, the district has diverted an average of 130 thousand acre- feet annually at Capay Diversion Dam on lower Cache Creek. No water supply from these sources was available during the 1977 and 1990 drought years. In Sutter County and in western Placer County, South Sutter Water District (SSWD) supplies irrigation water from Camp Far West Reservoir on the lower Bear River. SSWD also purchases surface water from Nevada Irrigation District to supplement irrigators' groundwater supplies. NID's supplies come from its reservoir on the Yuba-Bear River system. Yuba River supplies have also been developed by Yuba County Water Agency, which is New Bullards Bar Reservoir, the river's largest reservoir at 966 thousand acre-feet. The Sacramento metropolitan area, served by more than 20 water purveyors, is the largest urban area in the Sacramento River Hydrologic Region and is also the largest urban surface water user. Within Sacramento County, the City of Sacramento relies primarily on surface water (approximately 80 to 90 percent); water purveyors in unincorporated areas use both surface water and groundwater. The City of Sacramento diverts its CVP water supply from the American River at H Street and also diverts downstream from the confluence of the American and Sacramento rivers. The City of Folsom takes surface water from Folsom Lake.

Groundwater Supplies

Groundwater provides about 30 percent of the water supply for urban and agricultural uses in the region, and has been developed in both the alluvial basins and the hard rock uplands and mountains. There are 83 basins/subbasins delineated in the region. These basins underlie 5.053 million acres (7,900 square miles), about 29 percent of the entire region. The reliability of the groundwater supply varies greatly. The Sacramento Valley is recognized as one of the foremost groundwater basins in the state, and wells developed in the sediments of the valley provide sufficient supply to irrigation, municipal, and domestic uses. Many of the mountain valleys of the region also provide significant groundwater supplies for multiple uses. Geologically, the central portions of the Sacramento Valley is a large trough filled with sediments having variable permeabilities; as a result, wells developed in areas with coarser aquifer materials will produce larger amounts of water than will wells developed in fine aquifer materials. In general, well yields are good and range from 100 gallons per minute to several thousand gallons per minute. Because surface water supplies have been so abundant in the valley, groundwater development for agriculture for the most part has been used to supplement the primary surface supply.

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Water Uses

Comment [FG18]: This section needs work.

Water use in the Sacramento River region is mostly for agricultural production with more than 2 million irrigated acres in the year 2000. Agricultural products include a variety of crops such as rice and other grains, tomatoes, field crops, fruits and nuts. A substantial number of acres of rangeland in this region are also used for livestock management. Much of the economy of the region relies on agricultural water supplies, which are diverted and distributed through extensive systems of diversion canals and drains.

Comment [ljm19]: I added from update 2009. Can we get an more recent number? If not for PRD but maybe for final.

Basinwide, water use efficiency is generally high because many return flows from fields are captured by drainage systems and then resupplied to other fields downstream.

Water Conservation Act of 2009 (SB x7-7) Implementation Status and Issues

Thirty-five Sacramento River urban water suppliers have submitted 2010 urban water management plans to DWR. The Water Conservation Law of 2009 (SBx7-7) required urban water suppliers to calculate baseline water use and set 2015 and 2020 water use target. Based on data reported in the 2010 urban water management plans, the Sacramento River Hydrologic Region had a population-weighted baseline average water use of 271 gallons per capita per day and an average population-weighted 2020 target of 219 gallons per capita per day. The Baseline and Target Data for the individual Sacramento River urban water suppliers is available on the Department of Water Resources (DWR) Urban Water Use Efficiency website.

The Water Conservation Law of 2009 (SBx7-7) required agricultural water suppliers to prepare and adopt agricultural water management plans by December 31, 2012, and update those plans by December 31, 2015, and every 5 years thereafter. Five 2012 agricultural water management plans have been submitted to DWR, representing 13 Sacramento River agricultural water suppliers.

Water Balance Summary

The Sacramento River Hydrologic Region has eleven planning areas that range from sparsely populated mountainous areas to areas with populous major cities. See Table SR-3 Water Balance Summary and Volume 5 (Technical data) for more information on the water balances and portfolios.

PLACEHOLDER Table SR-3 Sacramento River Hydrologic Region Water Balance Summary, 2001-2010

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

The Shasta Pit Planning Area (PA501) averages about 17 TAF per year urban applied water. Agricultural applied water ranges from about 325 to 425 TAF per year. Managed wetlands use has decreased from about 13 TAF to 10 TAF per year. The McCloud River has a special Wild and Scenic River designation that was~~n't~~ not included in Update 2005 (water year 2001), but was included in subsequent years. This flow, which ranges from 950 to 1,865 TAF per year, is reused downstream.

Supply for ~~PA 501~~the Shasta Pit Planning Area is primarily local supply and reuse from the McCloud River, with about 100 acre-feet of groundwater extracted annually.

The Upper Northwest Valley Planning Area (PA 502) urban use is generally less than 1 TAF per year. Agricultural applied water ranges from 6.5 to over 13 TAF per year. There are no managed wetlands or instream environmental water use. Surface water consists of local deliveries (4-10 TAF per year), Central Valley Project deliveries (1 to less than 2 TAF) and reuse (0.5-1.3 TAF). Until 2008, generally less than 2 TAF of groundwater was extracted; from 2008 to 2010, the amount increased to about 5 TAF per year.

The Lower Northwest Valley Planning Area (PA 503) urban applied water is about 60 TAF per year. About half of the urban use is industrial and commercial. Agricultural applied water ranges from about

21

Comment [ebw20]: Table and text uncoordinated. Relate basin number in table to text or provide a table with water balances by PA's. A map showing PA's would help.

450 to more than 600 TAF per year. Instream requirements ~~in PA 503~~the Lower Northwest Planning Area 22
total about 2.2 MAF per year which leaves the planning area, but is reused downstream. About 200 acre-feet per year is applied to managed wetlands.

Supplies in ~~PA 503~~the Lower Northwest Valley Planning area consist primarily of CVP deliveries in 23
years when CVP water is available. In years when CVP water is not available, local sources are used. In addition, 250 to 360 TAF of groundwater is extracted each year.

The Northeast Valley Planning Area (PA 504) urban use is about 70-85 TAF, which is primarily residential. Agricultural use ranges from 250 to 350 TAF per year. Managed wetlands use about 1 TAF per year and there is no instream environmental. Supplies are about half surface water (local, reuse and CVP) and half groundwater.

The Southwest Planning Area (PA505) has about 10 to 11 TAF in urban applied water and 51 to 67 TAF in agricultural applied water. There is no environmental water use in this planning area. Surface water supplies (local deliveries and reuse, with a little CVP water) constitute about one-third to one-half of the supply, with groundwater extractions making up the difference.

The Colusa Basin Planning Area (PA 506) is primarily agricultural; with 2.1 to 2.7 MAF of agricultural applied water and only about 12-15 TAF of urban applied water. There are significant managed wetlands here (160-175 TAF per year) that are primarily associated with rice farming. Supplies are primarily surface water with most coming from the Central Valley Project deliveries and reuse. About 460-600 TAF of groundwater are also extracted.

The Butte-Sutter-Yuba Planning Area (PA 507) is similar to ~~PA 506~~the Colusa Basin Planning Area, but 24
with more urban, managed wetlands and agricultural use overall. There is also some instream environmental water (800 TAF to 1 MAF per year) that is reused with the same planning area. Groundwater supplies are about the same as in PA 506, with surface water supplies being primarily local deliveries. CVP and State Water Project deliveries total about 150 to 450 TAF per year. There is also significant reuse of surface water supplies.

The Southeast Planning Area (PA 508) covers the northern part of the Mountain Counties subarea. It has some urban and agricultural areas within its mountainous terrain. There are about 100 to 133 TAF of urban applied water and 330 to 400 TAF per year of agricultural applied water. There are generally 1.9 to 4.4 MAF of combined instream and wild and scenic applied water, most of which is reused downstream with the same planning area. There are some managed wetlands in which use varies from 1 to 17 TAF per year.

Water supplies are primarily surface water (local deliveries and reuse of instream environmental water) with about 50 to 60 TAF of groundwater extracted.

The Central Basin West Planning Area (PA 509) is also primarily agricultural in nature, with 55 to 80 TAF in urban use and 750 TAF to 1 MAF of agricultural applied water. There are about 22 to 30 TAF per year in instream flows and occasionally some managed wetlands use. Supplies are about half surface water (local deliveries, CVP, other federal deliveries, SWP and reuse) and half groundwater.

The Sacramento Delta Planning Area (PA 510) covers most of the Sacramento-San Joaquin Delta area that lies north of the confluence of the Sacramento and San Joaquin Rivers. There are about 20 to 40 TAF urban applied water and 400 to 700 TAF agricultural applied water in this planning area. Managed wetlands use about 15 to 60 TAF per year.

This is the planning area wherein the Required Delta Outflow for the state is measured. The amounts are statutorily set and are dependent upon water year type in the Sacramento River and San Joaquin River Regions. In our ten year study period, amounts ranged from 4.5 to 10.1 MAF per year. Supplies are primarily local surface water and inflows from other regions, with less than 40 TAF per year of groundwater extracted.

The Central Basin East Planning Area (PA 511) is the most metropolitan area in the hydrologic region, with between 380 and 480 TAF per year in urban applied water. Agricultural applied water ranges from 430 to 520 TAF per year. Managed wetlands use less than 2 TAF per year in applied water. Instream requirements use about 235 TAF per year and wild and scenic rivers 7 to 40 TAF, all of which is reused downstream.

Thirty to forty percent of the water is supplied by groundwater pumping and the rest is a combination of local surface water, CVP deliveries and reuse.

PLACEHOLDER Figure SR-4 Sacramento River Regional Water Balance by Water year, 2001-2010

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Project Operations

Comment [ljm21]: I am uncertain on whether this belongs here or under relationships with other regions. I added text under relationships with other regions to make it work as is but would welcome our editors suggestion on this.

The Bureau of Reclamation (USBR) and DWR operate the Central Valley Project (CVP) and the State Water Project (SWP) in accordance with a Coordinated Operations Agreement authorized by Congress though Public Law 99-546 in 1986. This agreement defines the rights and responsibilities of the CVP and SWP with respect to in-basin water needs and provides a mechanism to account for those rights and responsibilities. The agreement also works to provide coordinated operations for balanced conditions for the Sacramento Valley and the Delta while meeting water supply needs. “Balanced conditions” are defined as periods when releases from upstream reservoirs and unregulated flow approximate the water supply needed to meet Sacramento Valley in-basin uses and CVP/SWP exports (NMFS 2009).

Balanced conditions are further defined by biological opinions, SWRCB D-1641, SWRCB D-1485, and CVPIA 3406(b)(2). The 1993 NOAA Biological Opinion (BO) imposed operational constraints on the projects and introduced a combined CVP/SWP incidental take for Delta export facilities. The 2009 BO established in-stream temperature requirements, temperature management plans, end-of-September storage requirements, and restoration goals for the CVP. SWRCB D-1641 requirements include X2 standards, export/inflow ratios, and other operational requirements. SWRCB D-1485 ordered the CVP and SWP to guarantee water quality protection for agricultural, municipal and industrial (M&I), and fish and wildlife uses.

The CVP was first authorized in 1935 and reauthorized in 1992 through the Central Valley Project Improvement Act (CVPIA). The CVPIA modified the original 1937 act and added mitigation, protection, and restoration of fish, wildlife, and associated habitats as a project purpose. The act specified that the dams and reservoirs of the CVP be used: "first, for river regulation, improvement of navigation, and flood control; second, for irrigation, and domestic uses and fish and wildlife mitigation, protection, and restoration purposes; and third, for power and fish and wildlife enhancement."

The CVPIA also dedicated water to fish, wildlife, and habitat restoration on an annual basis. Of this amount, 800,000 acre-feet was dedicated to environmental needs as Section 3406(b)2 water, 200,000 acre-feet was designated for wildlife refuges, and 200,000 acre-feet was dedicated for increased Trinity River flows for fisheries restoration. Flexibility in project operations provides some of the dedicated water; however, the dedications also result in a reduction of CVP contractor water of 516,000 acre-feet per year on average and 585,000 acre-feet in dry years (USBR 2011a).

The goals and objectives mandated by the water quality plans, decisions, regulatory requirements, and hydrologic conditions complicate project operations and the ability to meet all water demands. Meeting water demands are further complicated under future climate change scenarios and the related uncertainties of water supplies. The following provides an overview of the projects and operational requirements.

The Central Valley Project

Shasta and Keswick Dams

Shasta Dam is the primary storage and power generating facility of the CVP. The watershed above dam drains approximately 6,650 square miles and has an average annual runoff of 5.7 maf. Shasta Lake has a capacity of approximately 4.5 maf. Annual releases from the dam range from 9 maf in wet years to 3 maf in dry years. Construction of temperature control facilities at the dam in 1997 enables the release of water from different levels of storage to help meet temperatures requirements downstream of Keswick Dam. Keswick Reservoir serves as an afterbay for releases from Shasta Dam and has a capacity of approximately 23,800 acre-feet. The dam also controls runoff from about 45 square miles of drainage area.

Operations at Shasta and Keswick dams are required to meet certain objectives and performance measures that affect flood control, water supply, water quality, riparian habitat, and the survival of several species within the Sacramento River. Flood control objectives for Shasta Lake require that releases be restricted to a flow of 79,000 cfs at Keswick Dam and a stage of 39.2 feet in the Sacramento River at Bend Bridge gauging station corresponding to a flow of approximately 100,000 cfs. A critical factor of flood operations is the amount of runoff entering the Sacramento River from Cottonwood Creek, Cow Creek, and Battle Creek. During rainfall events, local runoff between Keswick Dam and Bend Bridge can exceed 100,000 cfs (USBR 2004).

A storage space of up to 1.3 maf below full pool at the lake is kept available for flood management purposes. From December 23 to June 15, the required flood management space varies based on seasonal inflow. Daily flood management operations consist of determining the required flood storage space reservation and scheduling releases in accordance with flood operations criteria. The goal of existing operations is to have vacant flood storage space in excess of flood requirements and then fill the pool to the maximum extent possible for water supplies for the remainder of the year (USBR 2011a).

Historically, minimum navigation flows at Chico Landing were set at 5,000 cfs. This flow for navigation is no longer kept; however, water diverters have set their pump intakes just below this associated water level elevation. For this reason CVP has been operated to meet the navigation flow requirement of 5,000 cfs to Wilkins Slough under most water supply conditions. At flows less than 5,000 cfs, water diversion operations become impacted. At 4,000 cfs, some pumps become inoperable (McInnis 2011).

The flow objectives established for the Sacramento River at Rio Vista require minimum monthly average flows of: 3,000 cubic per second (cfs) during September of all year types, 4,000 cfs during October of all year types except critical years when flows of 3,000 cfs are required, and 4,500 cfs during November through December of all year types except critical years when flows of 3,500 cfs are required. The objective also requires that the 7-day running average flow is not less than 1,000 cfs below the monthly objective.

2009 Biological Opinion for Shasta Operations

With respect to water quality and habitat for salmon and steelhead, the 2009 BO for Shasta operations identified several objectives to avoid adverse effects on winter-run and spring-run salmon (McInnis 2011):

- Ensure a sufficient cold water pool to provide suitable temperatures for winter-run spawning between Balls Ferry and Bend Bridge in most years without sacrificing the potential for cold water management in a subsequent year
- Ensure suitable spring-run temperatures regimes, especially in September and October
- Establish a second population of winter-run salmon in Battle Creek
- Restore passage at Shasta Reservoir with experimental reintroductions of winter-run salmon to the upper Sacramento and/or McCloud rivers.

Actions to realize some of the above objectives focus on the End-of-September (EOS) Shasta Reservoir carryover storage. The storage capacity of Shasta Reservoir is approximately 4.5 maf. EOS storage objectives have been set at 2.2 maf and 3.2 maf to be met 87 percent and 40 percent of the time respectively. EOS storage is at 2.4 maf about 70 percent of the time. The EOS storage requirement of 2.2 maf is set to provide the water necessary to meet the minimum Balls Ferry temperature requirements for the following year (McInnis 2011).

Performance measures have also been established for water temperature at Clear Creek, Balls Ferry, Jelly’s Ferry, and Bend Bridge compliance points. From April 15 to September 30, water temperatures are not to exceed 56 degrees Fahrenheit between Balls Ferry and Bend Bridge. From October 1 and October 31, water temperatures are not to exceed 60 degrees Fahrenheit provided conditions are sufficient to support and sustain compliance.

A fall monthly release schedule is required to be developed by November 1st of each year based on EOS and hydrologic projections. Release schedules are based on habitat needs, flood control needs (a maximum end-of-November storage volume of 3.25 maf is necessary for flood control), Bay/Delta water quality requirements, and conservation of storage for next year’s cold water pool. If EOS is below 1.9 maf, Keswick releases will be reduced to 3,250 cfs unless higher releases are necessary to maintain temperature compliance points (McInnis 2011).

To conserve water in storage in the spring, USBR is required to make its February 15 forecast of deliverable water based on an estimate of precipitation and runoff at a 90 percent probability of exceedence. NMFS reviews the draft forecast to determine whether both a temperature compliance point at Balls Ferry (from May to October) and EOS storage of at least 2.2 maf can be achieved. Release schedules are then devised based on temperature compliance points, EOS requirements, nondiscretionary delivery obligations, and legal requirements (McInnis 2011). USBR is required to develop and implement an annual Temperature Management Plan by May 15 of each year for the period of May 15 through October 31 to manage cold water supplies within the Shasta Reservoir and Spring Creek to provide suitable temperatures for listed species.

PLACEHOLDER Box SR-1 Shasta Lake Water Resources Investigation (SLWRI) – Enlarging Shasta Dam and Reservoir

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Trinity River Diversion

In 1955, Congress authorized the construction of Lewiston and Trinity Dams on the Trinity River creating the Trinity River Diversion (TRD) for the export of water into the Central Valley. Operations of the TRD began in 1964 and were integrated with operations of Shasta Dam. Exports from TRD help to meet minimum flow requirements in the Trinity and Sacramento rivers, help to maintain reservoir storage levels, and facilitate operational compliance for water temperature below Keswick Dam.

Prior to construction of TRD, average annual discharge at Lewiston was approximately 1.2 maf with peak flows in excess of 100,000 cfs being recorded. Following construction of the dam, instream flow releases were set at 120,500 af/yr (10 percent of the average unimpaired flow). From 1964 to 1996, TRD exports accounted for 14 percent of Keswick releases (USFWS 1999). An outcome of TRD operations and the reduced instream flows of the Trinity River has been the degradation of fish habitat and reductions in anadromous fish populations. By 1980 it was estimated that fish populations had been reduced by 60 to 80 percent due to inadequately regulated harvest, excessive streambed sedimentation, and insufficient streamflow. The loss of fishery habitat was estimated to be 80 to 90 percent. To help address these problems, Congress passed the Trinity River Stream Rectification Act in 1980 (addressing sedimentation issues) and passed the Trinity River Basin Fish and Wildlife Management Act in 1984. The 1984 act directed efforts to restore fish and wildlife populations to levels that existed prior to TRD construction.

One of the provisions of the CVPIA was the establishment of a minimum flow volume for the Trinity River of 340,000 af. The CVPIA also directed the completion of a 12-year study (Trinity River Flow Evaluation Study (TRFES)) to establish permanent instream fishery flow requirements, operating criteria, and procedures for restoration and maintenance of the fishery (USFWS 1999). SWRCB Order 90-5 set temperature objectives for each reach of the river by season. The TRFES report recommended specific annual flow releases, sediment management, and channel rehabilitation to provide necessary habitat.

The Trinity River ROD of 2000 reduced the average annual export of the Trinity River to the Keswick Reservoir from 74 percent to 52 percent of flow. Since 2003, Trinity River restoration efforts have included improvements to floodplain infrastructure, channel rehabilitation, and peak flow releases. Since 2004 peak flow releases have ranged from 4,419 cfs to 10,100 cfs. Total annual flows have increased to a range of 368,600 to 452,600 af. Proposed future annual flows range from 368,600 to 815,000 af.

Sacramento River Division

The Sacramento River Division was authorized in 1950 to supply irrigation water to Tehama, Glenn, Colusa, and Yolo Counties. The unit consists of Red Bluff Diversion Dam (RBDD), Funks Dam, Corning Pumping Plant, Tehama-Colusa Canal (TCC), and the Corning Canal. Both canals provide irrigation water to approximately 100,000 acres. The TCC also provides water for about 20,000 acres of the Sacramento Valley Refuges. The division contains 18 water contractors. Each contractor has its own service contract with USBR which were renewed in 2005.

Construction of the RBDD was completed in 1964. Historically the gates of the dam were lowered by May 15th of each year creating Lake Red Bluff and raised on September 15th to allow for river flow through. The dam has had issues with fish passage and agricultural water diversion reliability since its construction and has impeded both the upstream migration of audit fish to spawning habitat and the downstream migration of juveniles impacting both winter-run and spring-run Chinook salmon (McInnis 2009). Upstream of the diversion dam is also critical spawning and holding habitat for green sturgeon. To facilitate fish passage, the NMFS 2009 Biological Opinion for the RBDD required that dam gates to be raised year-round by the year 2012. The diversion now includes a 2,500 cfs pumping plant and flat-plate fish screen to the existing canal headworks to replace the loss of the diversion structure.

American River Division (USBR 1994)

Comment [ljm22]: Is this a reference?

The American River Division of the Central Valley Project provides water for irrigation, municipal and industrial use, hydroelectric power, and recreation. It consists of the Folsom, Sly Park, and Auburn-Folsom South Units. The division is about midway between the northern and southern extremes of the Central Valley in Sacramento, San Joaquin, Placer, and El Dorado Counties. Division lands stretch from Sugar Pine Dam in the north to Stockton in the south. Most lands served by the Division lie in the southern portion of the Division, between Sacramento and Stockton.

In addition, units of the American River Division provide a high degree of flood control along the American River, protecting several communities including the California capital city of Sacramento. The American River Division consists of the Folsom, Sly Park, and Auburn-Folsom South Units.

The Folsom and Sly Park Units, though separate units of the American River Division, are often referred to together due to the fact that both units were authorized as part of the Central Valley Project by the same legislation.

The Sly Park Unit is made up of Sly Park Dam and Jenkinson Lake, Camp Creek Diversion Dam and Tunnel, and Camino Conduit and Tunnel. These provide municipal and industrial water for the nearby community of Placerville, and irrigation water for the El Dorado Irrigation District. Camp Creek Diversion Dam diverts a portion of the flow of Camp Creek to Jenkinson Lake via Camp Creek Tunnel, and Camino Tunnel and Conduit delivers water from Jenkinson Lake to the El Dorado Irrigation District for irrigation and municipal use. All features of the Folsom and Sly Park Units are complete and in operation.

The Folsom Unit consists of Folsom Dam and Lake, Folsom Powerplant, Nimbus Dam and Lake Natoma, Nimbus Powerplant, and Nimbus Fish Hatchery. Folsom Dam and Powerplant regulate the flow of the American River and provide water and power for municipal and industrial uses. Nimbus Dam and Lake Natoma act as an afterbay feature, regulating the outflows from the Folsom Powerplant. In addition, the Nimbus Powerplant provides supplemental electrical power to the area. The Nimbus Fish Hatchery compensates for the loss of salmon and trout spawning areas that were destroyed by construction of the dam. The lakes created by Folsom and Nimbus Dams provide recreation to thousands of people year round.

Authorized in 1965, the Auburn-Folsom South Unit originally consisted of Auburn Dam, Reservoir, and Powerplant, County Line Dam and Reservoir, Sugar Pine Dam and Reservoir, and the Folsom South Canal. The Auburn-Folsom South Unit was designed to provide a new and supplemental water supply for irrigation and municipal and industrial needs and to alleviate the badly depleted groundwater conditions in the Folsom South service area. It was about one third complete when construction was halted .

The completed portions of the project, Sugar Pine Dam and Reservoir, provide water for irrigation and municipal and industrial uses to the Foresthill Divide area.

The American River Division supplies water to several large municipal purveyors, including El Dorado ID, Foresthill PUD, Cities of Folsom, Roseville, Carmichael, Sacramento, as well as San Juan and Sacramento Suburban Water Districts.

Folsom and Nimbus Dams
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The American River Division supplies water to several large municipal purveyors, including El Dorado ID, Foresthill PUD, Cities of Folsom, Roseville, Carmichael, Sacramento, as well as San Juan and Sacramento Suburban Water Districts.

State Water Project

The SWP delivers water from northern California to users in the lower Sacramento Valley, San Francisco Bay area, San Joaquin Valley, and southern California. The DWR Oroville Field Division operates and maintains the facilities extending from Feather River lakes in Plumas County to the Oroville-Thermalito Complex on the Feather River. The facilities include three power plants, a fish hatchery, and a visitor's center. DWR operates the facility for water supply, power generation, recreation, fish and wildlife enhancement, and salinity control.

Lake Oroville has a storage capacity of 3,538,000 acre feet that is fed by the North, Middle, and South Forks of the Feather River. Average annual unimpaired flow into the lake is approximately 45 million acre feet. Local diversions are made directly from the Thermalito Afterbay by irrigation districts with water rights senior to the SWP. Oroville Dam provides up to 750,000 acre feet of flood control space.

DWR has operated the Oroville facilities under a license issued by the Federal Power Commission (FERC No. 2100-134) that expired on January 31, 2007. Prior to the expiration, DWR filed for a new license with the Federal Energy Regulatory Commission (FERC) for continued operation of the facility. On March 24, 2006, DWR filed a settlement agreement with FERC for a new license for up to 50 years. DWR currently operates the Oroville facilities pursuant to an annual license by FERC. The SWP generates about half of the power it uses to move water throughout the State.

Project Water Supplies

Estimated 2001 demands for CVP water are about 3.4 maf for the Sacramento Basin and 3.5 maf for Delta export areas (USBR 2004). DWR 2002 estimates the delivery for SWP water to be about 3.0 maf. Seventy percent of SWP water is supplied for M&I use providing water to about two-thirds of the State's population; the remaining 30 percent goes to agriculture - about 750,000 acres in San Joaquin Valley (CDWR 2007a). Estimated water demands for CVP and SWP water for the Sacramento Valley, Delta, and south of the Delta are summarized in Table SR-4 below.

PLACEHOLDER Table SR-4 2001 Estimates of Annual CVP/SWP Water Demand by Region

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

A breakdown of CVP water deliveries by water user is summarized below in Table SR-5

PLACEHOLDER Table SR-5 Estimates of CVP Deliveries by Water User (million acre-feet)(USBR 2004)

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

With the passage of the CVPIA, fish and wildlife share co-equal priority with other water users. One of the mandates of the act is for 800,000 acre feet of water to be left instream annually for fish, wildlife, and habitat restoration. In dry and critical water years, when deliveries to agricultural service contractors north of the Delta are reduced, this water can be reduced by up to 100,000 af. This water can be reduced by up to 200,000 af in critically dry water years (USBR 2011c). Another of the act's provisions was establishment of the Refuge Water Supply Program to meet the needs of 19 federal, State, and private wildlife refuges. Up to 555,515 acre-feet is to be supplied annually to refuges with 80 percent of the water provided by CVP supplies. During dry year conditions, this source of water can be reduced by a maximum of 25 percent.

Comment [ljm23]: I agree this is old information. I am thinking we can get updated information from DWR Bulletin 132.

Comment [FG24]: This seems too old.

PLACEHOLDER Box SR-2 The Monterey Agreement

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

CVP/ SWP Supply Reliability

Water availability in the Central Valley is dependent on hydrologic conditions and operational needs of the Sacramento Valley and the Bay-Delta. The allocation of CVP water for any given water year is based on forecasted reservoir inflows, amounts of water in storage, regulatory requirements, and management of CVPIA Section 3406(b)(2) resources and refuge water. Though hydrologic conditions are the primary driver with respect to the availability of water, the reliability of water supplies for water purveyors is dependent on the type of contract and policies for water allocation.

CVP Contracts

CVP water contractors in the Sacramento Valley fall into two categories: Sacramento River Water Rights Settlement Contractors and CVP Water Service Contractors. The contract terms and conditions vary depending on whether a contract is a water right, an agricultural water service, or a municipal/industrial type of contract.

Sacramento River Water Rights Settlement Contractors (SRSC) held water rights in the Sacramento Basin prior to construction of Shasta Dam. The water rights for SRSC exist independent of USBR. Supported by these underlying water rights, the CVP has contracts with SRSC totaling 2.2 maf for the Sacramento River and the San Joaquin River Exchange, and additional contracts totaling 0.9 maf for water right settlement contracts on the San Joaquin River. Contract amounts are supplied in full unless the forecasted Shasta Lake inflow constitutes a "Critical" water year. When Shasta Lake inflow is "Critical," San Joaquin Exchange contractor supplies may be limited to 650,000 acre-feet and Sacramento River and other San Joaquin water rights settlement supplies can be reduced by up to 25 percent (USBR 2004).

CVP Water Service Contractors can face greater cuts depending on water availability. These contractors are agricultural and municipal/industrial (M&I) contractors that have entered into water service contracts for supplemental supplies (project water). These supplies are not based on pre-existing water rights. Water deliveries for this type of contract can be cut up to 100 percent depending on supply, operational requirements, hydrologic conditions, and available reservoir storage.

Cutbacks in water deliveries can be regional or statewide. As an example, water conveyance limitations across the Delta can result in shortage conditions for water contractors located south of the Delta as compared to those located north of the Delta. In 2008 and 2009, Sacramento Valley water service contractors received 100 and 40 percent of their full contract supplies respectively, as opposed to 50 and 10 percent for San Joaquin Valley contractors (Strickland 2011).

Yuba River Development Project

The Yuba River Development Project, FERC 2246, is a water supply, flood control, and power generation project that was put into service in 1970. The project is located in the Yuba River watershed overlying portions of Yuba, Placer, and Sierra Counties.

The project includes New Bullards Bar (dam and storage reservoir), two diversion dams (Our House and Log Cabin), two diversion tunnels (Lohman Ridge and Camptonville, two power tun-nels (New Colgate and Narrows 2), and three powerhouses (New Colgate, New Bullards Bar Minimum Flow Powerhouse, and Narrows 2) for a combined capacity over 395 MW. The Yuba River Development Project (YRDP) does not include Englebright Dam and Reservoir, Daguerre Point Dam, or the Narrows 1 Powerhouse. Narrows 1 Powerhouse is operated by PG&E, FERC 1403.

New Bullards Bar Reservoir has an estimated storage capacity of 966,103 af with a minimum pool of 234,000 af, leaving 732,000 af that can be regulated. Storage capacity of 170,000 af, below full pool is kept available for flood management.

New Bullards Reservoir captures winter and spring runoff and is augmented by diversions from the Middle Yuba River and Oregon Creek. The reservoir is operated to meet minimum carryover storage requirements to ensure that instream flows are met and at least 50 percent of the surface water deliveries are available for the following year as a drought protection measure. In wetter years the reservoir is operated to an EOS target of 650,000 af. Other target levels are set for power generation and flood control operations. The average total inflow to the reservoir is about 1,200,000 af per year, ranging from 163,000 af to 2,800,000 af per year.

Englebright Dam (a USACE facility) was constructed in 1941 as a sediment retention facility. The lake is located downstream from New Bullards Bar at the confluence of Middle Fork and South Fork Yuba Rivers. Narrows 1 (PG&E) and Narrows 2 (YCWA) power plants regulate the flow from Englebright Dam and provide for high flow reservoir releases and increased flood control.

PLACEHOLDER Box SR-3 Lower Yuba River Accord

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Placer County Water Agency Pump Station Project

In March 2008, the Placer County Water Agency (PCWA) Pump Station Project was completed. PCWA was pursuing the development of a year-round water diversion facility capable of diverting up to 35,500 acre-feet annually of PCWA's water entitlements from its Middle Fork Project (MFP) on the American River and the USBR (Reclamation) constructed the facilities to meet PCWA needs.

Prior to 1972, PCWA had installed pumps to lift water supplies to the Auburn Ravine Tunnel for delivery to the PCWA service area. The original pump location interfered with the construction of the Auburn Dam Project (ADP) which started in 1972. USBR installed temporary pumps to lift the supplies, but these had to be removed before the rainy season because of inundation. The ADP construction was abruptly halted after a 1975 earthquake near Oroville which revealed a fault line that traversed the site of the thin arch dam and it soon became apparent the ADP was not to be restarted.

PCWA water supply still had to be addressed. The temporary pumps were problematic for both USBR and PCWA. The annual task of pulling the temporary pumps, re-installing and maintaining them each year was expensive and difficult, they were unreliable and they did not fully meet PCWA's water supply requirements.

In the 1990's PCWA needed greater access to its MFP water to meet its system demands and USBR was under increasing pressure to restore the river. The Pump Station Project would address PCWA's needs, but there were several challenges that had to be faced before USBR and PCWA could move forward with the project. The sudden halt of construction of the Auburn Dam left safety issues such as loose sediment, a coffer dam, and a dangerous diversion tunnel, conditions that had to be addressed before public access or the replacement of the pumps could be accomplished. Rafters and environment and recreation groups were demanding access to the three miles of river that were off limits to the public. The same groups were also concerned with the location of the permanent pump station even though engineering narrowed the possible siting of the station. The possibility of lawsuits continually loomed.

In 2001, USBR, PCWA, and critical local Congressional representatives agreed to "re-water" the half-mile project site and return the three-mile reach of the American River to the public. Work began in September 2003 and now that it is completed it will provide PCWA with the year-round access to its MFP water entitlements from the American River. With the work completed in 2008, PCWA has a secure site, greater and efficient pumping capacity, a restored river and aquatic environment and support from American River advocate groups. The new pumping station also has capacity for expansion for PCWA's additional water rights from the MFP.

Soon or Recently Implemented Projects

Placer County Water Agency Pump Station Project

In March 2008 the Placer County Water Agency Pump Station Project was completed. PCWA was pursuing the development of a year-round water diversion facility capable of diverting up to 35,500 acre-feet annually of PCWA's water entitlements from its Middle Fork Project (MFP) on the American River and the USBR constructed the facilities to meet PCWA needs.

Before the initiation of construction of Auburn Dam, PCWA had built 50-cubic feet per second (cfs) pump station on the North Fork American River to convey PCWA water supplies to the Auburn Ravine Tunnel for delivery to PCWA's service area. However, before PCWA's operations began, Reclamation removed the pump station in 1972 to facilitate construction of Auburn Dam. Reclamation has since installed a seasonal pump station annually as needed by PCWA to meet water supply demands.

Beginning in 1990, PCWA \ required access to its MFP water annually to meet its system demands under a variety of operating conditions. Reclamation has responded with the seasonal reinstallation and removal of PCWA's original pumps. Due to the location of the installation, the pumps have to be removed before winter each year to prevent damage due to inundation from high river flows. The seasonal pumps did not fully meet PCWA's water supply requirements, were not reliable, and became increasingly expensive to install and maintain. The project purpose included providing PCWA with the year-round access to its MFP water entitlements from the American River.

Freeport Regional Water Facility

The Freeport Regional Water Authority (FRWP) is a cooperative effort of the Sacramento County Water Agency (SCWA) and the East Bay Municipal Utility District (EBMUD) of Oakland to supply surface water from the Sacramento River to customers in central Sacramento County and the East Bay area of California. The diversion point and pumping facilities are located in the South part of Sacramento on the Sacramento River near the small community of Freeport. It provides SCWA with up to 85 million gallons of water per day (mgd) to supplement groundwater use in the central part of the county. EBMUD will use up to 100 mgd of this supply only during dry years, estimated to be three out of every 10 years, as a supplemental water source to complement existing conservation programs.

Construction of the FRWP facilities began in 2007 and became operational in Sacramento in 2011, with the completion of the Vineyard Surface Water Treatment Plant and supplies water to over 40,000 customers.

EBMUD's facilities were also completed in 2011, but EBMUD will only use FRWP water during dry years. Water from the FRWP will serve 1.3 million customers in Alameda and Contra Costa counties.

Projects Under Consideration, Actively Planned or Under Construction

Sacramento Regional WWTP upgrades to Tertiary The Central Valley Regional Water Quality Control Board has ordered a change in permitting requiring the Sacramento metropolitan area to reduce the amount of ammonia it discharges into the Sacramento River from its wastewater treatment plant.

The Sacramento Regional County Sanitation District was seeking a renewal of its permit to discharge secondary-level treated wastewater from its regional treatment plant near Freeport. The treatment plant, which utilizes several sedimentation processes, chlorination, de-chlorination, and the dilution power of the river, does not remove ammonia from the wastewater stream.

Recent studies suggested that ammonia and other nutrients may be disrupting the food web in the environmentally troubled Delta, contributing to the decline in native fish populations such as Delta smelt.

Effluent from the treatment plant has been identified as the largest single source of ammonia in the Delta watershed. The Sacramento Regional County Sanitation District has said upgrading the treatment plant to remove ammonia would cost approximately $800 million. The district has also said there is not enough scientific evidence to justify requiring the district to remove ammonia.

The draft discharge permit also requires the district to remove pathogens through tertiary filtration and disinfection, which the district estimates would cost an additional $1.3 billion. The draft permit proposes a 10-year timeframe for the district to comply with the new requirements and includes addressing all factors affecting the Delta's health.

There are concerns the upgrade could double customer rates by the end of construction in 2023. More information can be found online at: http://www.acwa.com/news/delta/draft-permit-could-require-changes-sacramento-regional-wastewater-treatment-plant and http://www.capradio.org/articles/2013/06/24/sacramento-wastewater-treatment-plant-to-upgrade/

Davis-Woodland Planned Diversion

In September 2009, the Cities of Woodland and Davis established the Woodland-Davis Clean Water Agency (WDCWA), a joint powers authority, to implement and oversee a regional surface water supply project.

The regional project will replace deteriorating groundwater supplies with safe, more reliable surface water supplies from the Sacramento River. Once complete, the project will serve more than two-thirds of the urban population of Yolo County, CA. It will also serve UC Davis, a project partner. The project goals are to provide a new water supply to help meet existing and future needs, improve drinking water quality and improve the quality of treated wastewater

The project plans include a jointly-owned and operated intake on the Sacramento River (WDCWA in partnership with RD 2035), raw water pipelines connecting the intake to a new regional water treatment plant, and separate pipelines delivering treated water to Woodland, Davis and UC Davis. Improvements to existing water supply systems will vary for Woodland and Davis and will include facilities such as distribution pipelines, water storage tanks and booster pump stations.

The project will divert up to 45,000 acre-feet of water per year from the Sacramento River. Water rights were granted in March 2011, and will be subject to conditions imposed by the state. Water diversions will be limited during summer and other dry periods. A more senior water right for 10,000 acre feet was purchased from the Conaway Preservation Group to provide summer water supply. Groundwater will continue to be used by Woodland and Davis during when demand for water cannot be met with surface water supplies alone.

The water treatment facility will be constructed to supply up to 30 million gallons of water per day, with an option for future expansion to 34 million gallons per day. Of that amount, Woodland's share of treated surface water will be 18 million gallons per day, with Davis' share at 12 million gallons per day. Approximately 5.1 miles of pipeline will transport "raw" water from the surface water intake on the Sacramento River to the water treatment plant located south of Woodland (see map). From there, the treated water will travel 7.8 miles via pipeline to Davis and up to 1.4 miles to Woodland. http://www.wdcwa.com/the_project

North Bay Aqueduct Alternative Intake

The California Department of Water Resources (DWR) proposes to construct and operate an alternative intake on the Sacramento River, generally upstream of the Sacramento Regional Wastewater Treatment Plant, and connect it to the existing North Bay Aqueduct (NBA) system by a new segment of pipe. The proposed alternative intake would be operated in conjunction with the existing NBA intake at Barker

Slough. The North Bay Aqueduct Alternative Intake Project (NBA AIP or proposed project) would be designed to improve water quality and to provide reliable deliveries of State Water Project (SWP) supplies to its North Bay contractors, the Solano County Water Agency (SCWA) and the Napa County Flood Control and Water Conservation District (Napa County FC&WCD).

DWR, the Lead Agency under the California Environmental Quality Act (CEQA), is preparing an Environmental Impact Report (EIR). As part of the public involvement process for the EIR, the lead agencies asked for input on the scope of the NBA AIP EIR through a series of meetings and a written comment period (scoping). ~~A Notice of Preparation (NOP) of an EIR is prepared and distributed to solicit views of interested persons, organizations, and agencies regarding the scope and content of the environmental review to be included in the EIR; specifically, views on the scope of the environmental analysis, alternatives to be considered, and potential mitigation measures.~~

~~This report presents a summary of the issues raised during scoping. Comments received on CEQA issues will be considered by DWR for incorporation, as appropriate, in the Draft EIR (DEIR) analysis.~~

~~Other issues were raised that do not address the CEQA environmental process. These comments will be considered by DWR and are part of the record but will not be included in the DEIR analysis. This Scoping Report describes the public review process undertaken by DWR and summarizes the written and oral comments received during the public review period for the NOP.~~

Comment [ljm25]: This looks like it was copied from the scoping document without rewriting. I suggest cutting.

Natomas Mutual Water Company converting irrigation supplies to urban uses
Natomas Central Mutual Water Company controls water rights for use on 55,000 acres of agricultural lands in Northwest Sacramento and Southern Sutter County. Their 120,000 acre feet of water rights are held in 6 licenses, 5 of which allow for irrigation, industrial, municipal and domestic use. Besides its licenses, NCMWC has other permits for winter water from the Sacramento River, drainage water and groundwater facilities.

NCMWC has engaged Golden State Water Company to service 7,500 acres approved by the Sutter County voters for development. Sutter Pointe is a proposed planned community is located approximately 4 miles north of the City of Sacramento. It is Sutter County's largest development and would accommodate 47,000 to 49,000 people over a 20 to 30-year build-out. The plan calls for 17,500 homes, 20,000 jobs, 3,600 acres (1,500 ha) of employment designated uses, and 1,000 acres (400 ha) of community service uses, which includes parks, schools, open space and other community facilities.

Work on infrastructure, such as roads and levees, which will service the development, has been ongoing. However, the Sutter Pointe as a construction project has not yet started, probably due to the area’s economic slowdown. Additional information can be found at: http://www.cpuc.ca.gov/Environment/info/esa/gswc_sp/index.html

The Sacramento River Diversion
This is a joint venture for PCWA and City of Sacramento. Prior to the economic slowdown of 2008, Placer County Water Agency (PCWA) was the lead agency pursuing a new diversion from the Sacramento River. The project is expected to continue, but not at this time.

PCWA has a 35,000 acre-foot water right was established by the Water Forum Agreement of 1997, a formal agreement of water purveyors, environmentalists, agriculturalists, business leaders, along with city and county governments in Sacramento, El Dorado and Placer counties promoting ecosystem preservation along the lower American River. Along with PCWA, the Cities of Sacramento and Roseville, and the Sacramento Suburban Water District have their own allocations from this new diversion and were to take part in funding the project.

The new supplies from the Sacramento River are being planned for the expected growth in the Northern Sacramento, and Western Placer County area. The point of diversion is Natomas Central Mutual Water Company facility several miles upstream from the confluence of the American and Sacramento Rivers. Supplies will be conveyed via pipeline to the treatment facilities within the individual purveyor service areas.

However, with the economic slowdown at the end of the last decade, the project is on hold. The project is the most economical option for PCWA to increase its supplies, so the project will probably be pursued again soon. The City of Sacramento and the other entities are also not pursuing the project at this time. Addition information can be found at: https://ucmshare.ucmerced.edu/docushare/dsweb/Get/Document-105308/02_exec_summ.pdf

Water Quality

Generally, water quality in the Sacramento Valley is good for both surface water and groundwater; however, an issue getting increased attention is the salinity of surface water and the subsequent salt loading that occurs for south of Delta exporters (CVRWQCB 2011b). Salinity impacts to groundwater are also a concern with respect to municipal wastewater recycling.

Water Boards throughout the State adopt basin plans that layout a framework for how the Board will protect water quality in each region. The basin plans designate the beneficial uses and establish an implementation program to achieve the water quality objectives and protect the beneficial uses. The implementation program describes how the Board will coordinate its regulatory and non-regulatory programs to address specific water quality concerns.

A primary goal of the Board is to develop a comprehensive salt and nitrate management plan for the Central Valley. The long term plan will identify and require discharger implementation of management measures aimed at the reduction and/or control of major sources of salt and nitrate as wells as support activities that alleviate known impairments to drinking water supplies.

Surface Water Quality

Central Valley Salinity

Salinity levels (measured as Electrical Conductivity (EC)) within the Sacramento Hydrologic Region are low compared to other regions of the State. EC levels within upper reaches of the Sacramento River range from 84 - 140 µmhos/cm and gradually increase downstream. Irrigation return flows increase the salinity of the river for most of the year except during spring. Feather River has lower salinity levels than the Sacramento River and dilutes EC below the confluence of the two rivers. Though EC levels are relatively low, the volume of water exported south of the Delta is a concern with respect to the total salt load being exported to those regions because exported water picks up additional salts in contact with peat soils and tidal influenced waters. Salt management is considered the most serious long-term water quality issue in the central valley. More salt enters than leaves the San Joaquin River Basin resulting in unavoidable degradation of groundwater. This is a focus of the Central Valley Regional Water Quality Control Board's Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS initiative).

The CV-SALTS initiative will include basin plan amendments that will establish regulatory structure and policies to support basin-wide salt and nitrate management. The regulatory structure will have five key elements:

- Refinement of agricultural supply, municipal and domestic supply, and groundwater recharge estimates
- Revision of water quality objectives for these uses
- Establishment of policies for assessing compliance with the beneficial uses and water quality objectives
- Establishment of management areas where there are large scale differences in baseline water quality, land use, climate conditions, soil characteristics and existing infrastructure and where short and long term salt and/or nitrate management is needed
- Development of an overarching framework to provide consistency for the development of management plans within the management areas.

In a related issue, the goal of the State Water Board Recycled Water Policy is to have a salt/nutrient management plan for every groundwater basin in California to be developed by local stakeholders. The plan is to be adopted by the Regional Water Board into its Basin Plan. Plans are due to the Regional Board by May 2014.

As part of the CVRWQCB triennial review of the Water Quality Control Plan for the Sacramento River, Board staff has started the assessment of municipal and domestic water supply beneficial use relative to the water quality objectives for agricultural water bodies for the Cities of Willows, Colusa, Live Oak, and Biggs (CVRWQCB 2012).

Metals from Mining

Legacy issues associated with historic mining activities continue to be a problem today. Copper, cadmium, zinc, and lead are metals that are naturally found in high concentrations in the "Copper Crescent" in Shasta County. Mining activities increase the amount of metals that enter nearby waterways. Water bodies in the area are impaired due to the elevated levels of copper, cadmium, zinc and lead. These metals are toxic to aquatic life at elevated concentrations although concentrations that are toxic to aquatic life may not be high enough to cause human health impacts.

Copper mining in the Upper Feather River watershed has also caused copper, cadmium and zinc impairments in several of the Upper Feather River tributaries. The largest mine in this area is the Walker Mine, an inactive copper mine about 12 miles east of Quincy in Plumas County. Acidic and metal-laden water (acid mine drainage) discharging from the mine and tailings has long affected the nearby streams of Dolly Creek and Little Grizzly Creek. The discharge was reported to have eliminated aquatic life in Dolly Creek, downstream from its confluence with the mine drainage, and in Little Grizzly Creek downstream from its confluence with Dolly Creek for a distance of approximately ten miles from the mine. Little Grizzly Creek flows to Indian Creek, a tributary to the North Fork of the Feather River.

Inorganic mercury enters waterways when soils erode, atmospheric dust falls to the ground, and mineral springs discharge. Another significant source is cinnabar ore (mercury sulfide) that was mined in the

Inner Coast Ranges for elemental mercury (quicksilver). This liquid form of mercury was transported from the Coast Ranges to the Sierra Nevada for gold recovery where several million pounds of mercury were lost to the environment during the gold rush. In various aquatic environments, inorganic mercury can be converted to methylmercury which is a potent neurotoxin. Methylmercury is readily absorbed from water and food, and therefore concentrations multiply greatly between water and top predators of aquatic food chains. The cumulative result of this bioaccumulation is more than a million-fold increase in concentrations of methylmercury in predatory fish such as bass and fish-eating wildlife such as terns and eagles (SRWP 2010).

Many streams and reservoirs in the Sacramento River Hydrologic Region contain fish with elevated concentrations of methyl mercury. Cache Creek is one source that transports mercury from abandoned and orphaned mercury mines in the Coast Range to the Cache Creek Settling Basin and eastward to the Yolo Bypass. Cache Creek accounts for 60 percent of the mercury discharged within the Central Valley (USEPA 2012a).

Pesticides

In the last six years, urban storm sewer outfalls draining new development in western Placer County and the City of Sacramento were identified sources of pyrethroid-caused aquatic toxicity (EPA 2012b). In 2011, the California Department of Pesticide Regulation (DPR) issued two sets of draft surface water protection regulations addressing pesticide applications. The first set of regulations prohibits pesticide application within 100 feet from a sensitive aquatic resource and also to saturated soils within 48-hours of a predicted storm event. The regulations require retention of irrigation runoff up to four weeks after application and restrict pesticide application to spot and crack-and-crevice treatment on impervious surfaces (EPA 2012b).

DPR's second set of regulations are intended to reduce pyrethroid pesticide use for outdoor non-agricultural uses. The regulations identify application methods depending on the type of impervious surface being treated (USEPA 2012a). The CVRWQCB is addressing pesticide-caused aquatic resource impairments through the Nonpoint Source Program, Irrigated Lands Regulatory Program (ILRP), stormwater permits, TMDLs, and new water quality criteria (USEPA 2012a).

The CVRWQCB is developing water quality criteria and related TMDLs for current use pesticides for all waterways in the central valley that support aquatic life. Phase I of this effort includes organophosphate pesticides (diazinon and chlorpyrifos). Phase II will address pyrethroid pesticides and possibly other pesticides of concern (USEPA 2012a).

In 2012, the SWRCB issued a draft statewide general stormwater permit for small Municipal Separate Storm Sewer Systems (MS4s) which cover municipalities with a population less than 100,000. The draft permit requires the permittee to evaluated the use of pesticides and reduce pesticide discharges.

PLACEHOLDER Box SR-4 Central Valley Regional Board Irrigated Lands Regulatory Program

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Groundwater Quality

The following contaminants have been found to occur regionally in groundwater:

- Arsenic
- Boron
- Localized contamination by organic compounds and nitrates
- Hexavalent Chromium.

High concentrations of arsenic have been found in wells located towards the center of the Sacramento Valley along the Sacramento and Feather rivers. The source of the arsenic is from minerals dissolved from the volcanic and granitic rocks of the Sierra Nevada Mountains.

Boron has been detected at concentrations greater than the non-regulatory human-health notification levels of 1,000 µg/l in several aquifers located within southern and middle parts of Sacramento Valley. High concentrations of boron found in wells located along Cache and Putah Creeks are likely associated with old marine sediments from the Coast Ranges.

PCE levels exceeding maximum contaminant levels (MCLs) have been detected in a number of water systems in Butte County and Sacramento County. PCE was the main solvent used for dry cleaning. Its occurrence is also associated with textile operations and degreasing operations.

Nitrate levels in public supply wells along the west side of the Sacramento Valley have occasionally exceeded the MCL but most of the concentrations are well within the MCL except for a public water supply system located in Olivehurst. Groundwater in the Chico urban area and the Antelope area of Red Bluff also has high nitrate levels. For the Chico urban area, the Central Valley Water Board has issued a prohibition of discharge from individual disposal systems in the area.

Concentrations of Chromium at levels above the detection limit (above 1 µg/l) have been detected in many active and standby public supply wells along the west or valley floor portion of the valley. Chromium is a metal found in natural deposits of ores containing other elements, mostly as chrome-iron ore. Sampling of drinking water throughout California suggests that hexavalent chromium may occur naturally in groundwater in many locations.

The Central Valley Water Board has developed and approved a groundwater quality protection strategy. The strategy makes recommendations on how to implement existing regulations and to achieve groundwater protection goals. Recommendations from the strategy are the following:

- Development of Salt and Nutrient Management Plan.
- Implement groundwater monitoring program. Monitoring will focus on water quality and waste discharge requirements.
- Implementation of groundwater protection programs through IRWM Plan Groups.
- Broaden public participation in all programs.
- Coordinate with State and local agencies to implement a Well Design and Destruction Program
- Development of a groundwater quality database.
- Establishment of a regulatory process for alternative methods of dairy waste disposal.
- Development of individual and general orders for confined animal feeding operations.
- Implementation of a long-term irrigated lands program. To date, the Board has developed the first set of draft Waste Discharge Requirements under the irrigated lands program.

- Coordination with California Department of Food and Agriculture to identify methods to enhance fertilizer program.
- Reduce site cleanup backlog.
- Draft waiver following new regulations adopted based on AB 885. (AB885 requires the State Water Board to develop regulations or standards for the permitting and operation of specified categories of onsite sewage treatment systems.)
- Update guidelines for waste disposal for land developments.
- Develop methods to reduce the backlog and increase the number of facilities regulated.

PLACEHOLDER Box SR-5 Central Valley Regional Board Water Quality Certification Program

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Drinking Water Quality

The region has an estimated 504 community drinking water systems. The majority (over 80%) of these community drinking water systems are considered small (serving less than 3,300 people) with most small water systems serving less than 500 people (see Table SR-6). Small water systems face unique financial and operational challenges in providing safe drinking water. Given their small customer base, many small water systems cannot develop or access the technical, managerial and financial resources needed to comply with new and existing regulations. These water systems may be geographically isolated, and their staff often lacks the time or expertise to ~~make needed infrastructure repairs;~~ install or operate new treatment systems; or develop comprehensive source water protection plans, financial plans or asset management plans (USEPA 2012) while continuing day-to-day operations and mandatory reporting.

PLACEHOLDER Table SR-6 Summary of Large, Medium, Small, and Very Small Community Drinking Water Systems

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Medium and large water systems account for less than 20% of region's drinking water systems; however these systems deliver drinking water to over 90% of the region's population (see Table SR-7). These water systems generally have financial resources to hire staff to oversee daily operations and maintenance needs, and hire staff to plan for future infrastructure replacement and capital improvements. This helps to ensure that existing and future drinking water standards can be met.

In general, drinking water systems in the region deliver water to their customers that meet federal and state drinking water standards. Recently the Water Boards completed a draft statewide assessment of community water systems that rely on contaminated groundwater. This draft report identified 61 community drinking water systems in the region that rely on at least one contaminated groundwater well as a source of supply (See Table SR-8). Arsenic is the most prevalent groundwater contaminant affecting 73 community drinking water wells in the region. A number of community drinking water wells are also affected by nitrate and tetrachloroethylene (PCE) contamination (see Table SR-8). The majority of the affected systems are small water systems which often need financial assistance to construct a water treatment plant or alternate solution to meet drinking water standards.

PLACEHOLDER Table SR-7 Summary of Small, Medium, and Large Community Drinking Water Systems in the Sacramento River Hydrologic Region that Rely on One or More Contaminated Groundwater Well(s)

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

PLACEHOLDER Table SR-8 Summary of Contaminants Affecting Community Drinking Water Systems in the Sacramento River Hydrologic Region

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Aquifer Conditions and Issues

This section is under development.

Flood Management

Risk Characterization

Major floods are common in the Sacramento River Hydrologic Region. Slow rise flooding would be nearly the exclusive cause of floods, but many miles of old and new levees, the older ones often raised by using materials at hand, has resulted in a high incidence of structure failure floods. Coastal flooding, caused by inundation due to water-level rise, occurs in the Delta and at Clear Lake. Some of the least substantial levees are in the Delta, where they are subject to continuous waterside inundation. Delta floods have been listed as coastal when levee failure is not a contributor, and as structure failures when levees breach. Flood damage has been observed in the Sacramento River Hydrologic Region since at least 1805. Since the era of building levees began, floods have become less frequent and more damaging. Figures SR-5 and SR-6 provide statistics on the region's exposure to the 100-year and 500-year floodplains.

PLACEHOLDER Figure SR-5 Statewide Flood Hazard Exposure to the 100-Year Floodplain

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

PLACEHOLDER Figure SR-6 Statewide Flood Hazard Exposure to the 500-Year Floodplain

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Damage Reduction Measures

Traditionally, the approach to flood management has been to alter or confine natural watercourses to reduce the chance of flooding, minimizing damage to lives and property. This approach looked at floodwaters primarily as a potential risk to be mitigated. Much of the Central Valley now derives its flood protection from the State Plan of Flood Control (SPFC). The SPFC refers to the facilities, lands, programs, conditions, and mode of O&M for the State/Federal flood protection system.

The SPFC system includes the following major facilities:

- About 440 miles of river, canal, and stream channels (including an enlarged channel of the Sacramento River from Cache Slough to Collinsville)
- About 1,000 miles of levees (along the Sacramento River channel, Sutter and Yolo basins, and Feather, Yuba, Bear, and American rivers)

Comment [ljm26]: I took this directly from the flood futures report. Should add the FFR as a reference.

Comment [FG27]: From 20XX to 20XX, the state of California spent huge $$$ to alleviate flood risk. (JPA/EIP) please ask Terri Wegener for this number

FG: Update: They are still working on it as of 9/20

- Four relief bypasses (Sutter, Tisdale, Sacramento, and Yolo bypasses)
- Knights Landing Ridge Cut to connect the Colusa Basin to the Yolo Bypass
- Five major weirs (Sacramento Weir, Fremont Weir, and Moulton, Tisdale, and Colusa weirs)
- Two sets of outfall gates
- Five major drainage pumping plants (CDWR 2012)

These facilities were constructed as part of several large flood control projects:

- Sacramento River Flood Control Project
- Sacramento River and Major and Minor Tributaries Project
- Sacramento River Bank Protection Project
- American River Flood Control Project
- Sacramento River Project, Chico Landing to Red Bluff
- Middle Creek Project
- North Fork Feather River Project

The Sacramento River Flood Control Project (SRFCP) is an umbrella term for six large USACE projects that, together with six reservoirs on the major rivers, constitute the State's largest flood management system. The SRFCP includes levees, bypasses, weirs, a debris basin, and appurtenant facilities. It extends from Elder Creek in Tehama County downstream to the Delta, a distance of 230 miles along the Sacramento River. The SRFCP has levees or other facilities on 5 major rivers, 15 creeks, and 13 sloughs. It incorporates 6 bypasses and 11 other constructed or improved channels. The project protects wide areas of the Sacramento Valley along the river and its tributaries, from the town of Tehama to downstream of Rio Vista.

The Sacramento River and Major and Minor Tributaries Project is another large project that was developed to reduce flooding and supply reservoir storage along the Sacramento River. The project also included levee construction and revetment, channel enlargement, and other tributary improvements.

The Sacramento River Project, Chico Landing to Red Bluff, was a modification and extension of the existing SRFCP that provided bank protection and channel improvements. The Sacramento River Bank Protection Project (SRBPP) is an ongoing project to construct bank erosion control works and setback levees within the limits of the existing levee system.

The American River Flood Control Project was developed to reduce flood risk along the lower American River between Carmichael Bluffs and the terminus of the SRFCP levee near the State Fairgrounds. The Middle Creek Project was developed to address localized flooding issues upstream of Clear Lake. The North Fork Feather River Project was developed to address localized flooding near Chester, California. This project consisted of construction of diversion dam, channel, and levees.

USACE bank protection projects in the region include:

- Sacramento River from Chico Landing to Red Bluff
- Diversion dam, channel, and levees on the North Fork Feather River at Chester
- Diversion channel, levees, and a pumping plant on Middle Creek and tributaries near Upper Lake
- Improved channel for the Pit River through Alturas

The region's eight major reservoirs with flood management reservations are Shasta Lake on the Sacramento River, Folsom Lake on the American River, Lake Oroville on the Feather River, New Bullards Bar Reservoir on the North Yuba River, Indian Valley Reservoir on North Fork Cache Creek, Highland Springs Reservoir on Highland Creek, Black Butte Lake on Stony Creek, and a small reservoir on Adobe Creek. USACE controls the flood management space on Shasta Lake, Folsom Lake, Black Butte, New Bullards Bar, and Lake Oroville reservoirs. Clear Lake, a natural lake, intercepts numerous tributaries to moderate Cache Creek. For the complete list of infrastructure in the Sacramento River Hydrologic Region refer to the California's Flood Future Report Attachment E: Information Gathering Technical Memorandum.

Today, water resources and flood planning involves additional demands and challenges, such as multiple regulatory processes and permits, coordination with multiple agencies and stakeholders, and increased environmental awareness. These additional complexities call for an Integrated Water Management (IWM) approach that incorporates natural hydrologic, geomorphic, and ecological processes to reduce flood risk. Some agencies are transitioning to IWM which is integral to the 2012 Central Valley Flood Protection Plan (CVFPP).

The CVFPP proposes a system-wide investment approach for sustainable, integrated flood management in areas currently protected by facilities of the State Plan of Flood Control. A substantial portion of the Sacramento River Hydrologic Region is within the implementation area of the CVFPP. The CVFPP is a flood management planning effort that addresses flood risks and ecosystem restoration opportunities in an integrated manner while concurrently improving ecosystem functions, operations and maintenance practices, and institutional support for flood management. Under this approach, California will prioritize investments in flood risk reduction projects and programs that incorporate ecosystem restoration and multi-benefit projects. The CVFPP was adopted by the Central Valley Flood Control Board on June 29, 2012. It is expected that the CVFPP will be updated every 5 years thereafter. The CVFPP proposes to address the following issues:

- Physical improvements in the Sacramento and San Joaquin River basins
- Urban flood protection
- Small community flood protection
- Rural/Agricultural area flood protection
- System improvements
- Non-SPFC levees
- Ecosystem restoration opportunities
- Climate change considerations

PLACEHOLDER Box SR-6 Managing Levee Improvements in Yuba County

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Water Governance

Development of California's water over time has resulted in several different agencies providing multiple layers of governance and management. Local, State, Tribal, and federal agencies each provide some level of resource management and have mandates (sometimes conflicting mandates) to meet the needs of the environment, and urban and agricultural water users. For the management of surface water there are approximately 145 settlement contractors and about 32 agricultural, municipal, and industrial water contractors in the region. Responsibilities for flood management are spread among more than 460 agencies, many with different governance structures. There are up to 41 water utilities.

Several resource planning efforts have been developed in the region since 2000. These efforts have been sub regional and regional in scope and are generally supported by specific stakeholder types. Planning goals have generally been focused on sub regional water supply needs or regional in scope to meet environmental needs. Regional planning efforts have included:

- Basinwide Water Management Plan
- Sacramento Valley Water Management Agreement
- Redding Basin Water Resources Management Plan
- Regional Water Use Efficiency Program
- Butte Integrated Water Resources Program
- Yuba-Sutter Regional Recycled Water Master Plan

Regional planning and policy development is now becoming more of a role for the regional IRWM groups. Several groups in the Sacramento River region are currently at some level of plan development. These efforts are providing a vehicle for more collaborative dialogue and intergovernmental cooperation on local water issues. Regional IRWM groups include the following:

- Upper Pit Watershed
- Upper Sacramento-McCloud
- Upper Feather River Watershed
- Consumnes American Bear Yuba
- North Sacramento Valley Group
- Westside (Yolo, Solano, Napa, Lake,Colusa
- Yuba County

Flood Agencies and Responsibilities

Although primary responsibility might be assigned to a specific local entity, aggregate responsibilities for flood management are spread among more than 460 agencies in the Sacramento River Hydrologic Region with many different governance structures. For a list of the entities that have responsibilities or involvement in flood and water resources management, refer California's Flood Future Report California's Flood Future Report Attachment E: Information Gathering Technical Memorandum. More detail on flood management in the Sacramento Valley can be found in the Central Valley Flood Protection Plan.

Current Relationships with Other Regions and States

As discussed above in the regional resource management conditions the Sacramento River Region is the location of the headwaters of both the State Water Project and the Central Valley Project. As a result this region does have an relationship with the Trinity River through the Trinity River Diversion which passes through this region and water is delivered out of the region through these projects to other many parts of the State. A full understanding of this region is incomplete without an understanding of the interrelationship with these water projects.

Comment [FG28]: Delete?

Comment [ljm29]: I added text to direct the reader to the extensive material we have in the regional resource management conditions above. We could move the Project Operations content down here as an alternative to this text.

Regional Water Planning and Management

Integrated Regional Water Management Coordination and Planning

Eight Integrated Regional Water Management regions have been formed and accepted for the Sacramento River Hydrologic Region. They are identified as the American River Basin, Consumes American Bear Yuba, Northern Sacramento Valley, Upper Feather River Watershed, Upper Pit River Watershed, Upper Sacramento-McCloud, Westside (Yolo, Solano, Napa, Lake, Colusa), and Yuba County. Presently, the members of each group are either in the process of developing an IRWM Plan for their area or updating an existing Plan to meet current standards. IRWM members and stakeholders have reached out to a wide range of interest groups for assistance with the development of strategies to resolve current and future water management challenges in the region. The Sacramento River region has many tribes and disadvantaged communities and the IRWM groups are involving them in the planning process.

As a result of IRWM planning efforts, local agencies and stakeholders have developed an array of projects and programs to meet their IRWM regional water management objectives. The array includes projects that will sustain existing and future surface water and groundwater supplies and protects the environment. IRWM Regions with existing Plans are implementing projects that include habitat restoration, invasive species control, water use efficiency, and water and wastewater improvements. The newer IRWM regions are prioritizing projects that have been identified through the planning process. These projects include the types being implemented by the established IRWM regions as well as water storage, water quality improvements, habitat an watershed restoration, fish passage, groundwater recharge, flood mitigation and protection, database development, computer modeling of surface and ground water, and well abandonment.

Accomplishments

CALFED Ecosystem Restoration Program

With the signing of the CALFED Programmatic Record of Decision (ROD) in 2000, restoration efforts were put in motion which set the long-term direction of the 30-year CALFED program. The CALFED Program is made up of the Levee System Integrity Program; Water Quality Program; Ecosystem Restoration Program (ERP); Water Use Efficiency Program; Water Transfer Program; Watershed Program; Storage Program; and Conveyance Programs. The implementing agencies are the U.S. Fish and Wildlife Service, California Department of Fish and Wildlife, and the National Marine Fisheries Service.

The intent of the ERP and Watershed Program is to restore the Bay-Delta ecosystem and recover listed species in the watersheds above the Bay-Delta Estuary. The foundation of the ERP is the restoration of processes associated with stream flow, stream channels, watersheds, and floodplains (CDFG 2010). The purpose of the Watershed Program is to promote resource management programs and projects at the watershed level and to improve local management capacity within watershed communities. The program has helped to establish and maintain locally-led watershed restoration, maintenance, conservation, and monitoring efforts, and have improved the scientific basis for flow-related actions.

The ERP was designed as a two stage program. Implementation of Stage 1 began shortly after the issuance of the ROD. Stage 1 covered the first seven years of the 30-year program with the intention of building a foundation for long-term program actions. ERP studies and restoration projects have helped to identify how the Sacramento River flow regime and management actions influence habitats, species, and hydrogeomorphic processes (CDFG 2011). Example Stage 1 restoration projects include:

- Fish passage improvement projects on Butte Creek, Battle Creek, Clear Creek, and Mill Creek
- Habitat restoration in the Yolo Bypass
- Construction of two fish ladders and improvement of fish screens at the Anderson Cottonwood Irrigation District dam
- Restoration of Battle Creek Salmon and Steelhead habitat through the removal of five dams and the addition of screens and ladders to three other dams
- Construction of a new screen structure at Red Bluff Diversion Dam.

Stage 2 is intended to focus on the needs of species and ecosystem components considered to be at high risk. The program focus will be on habitat restoration, rehabilitation of ecological processes, reduction of stressor impacts and on the actions necessary to meet specific information needs (CDFG 2010). Examples of actions and projects identified include:

- Continue to prioritize fish habitat and fish passage restoration projects particularly for spring-run Chinook salmon and steelhead trout
- Restore 50 to 100 miles of tidal channels in the Yolo Bypass by constructing a network of channels within the bypass that connect to the Delta
- Remove small, non-essential dams on gravel-rich streams
- Establish weed control programs to suppress the expansion of tamarisk, giant reed, locust, and other invasive non-native plants degrading habitat quality and native flora
- Design, permit, and construct priority fish screen projects on the Sacramento River
- Investigate whether individual species' respective range of distribution can be extended or changed.

National Marine Fisheries Service Central Valley Salmon and Steelhead Recovery Plan

The Endangered Species Act requires the NMFS to develop and implement recovery plans for listed species. The recovery plan for Sacramento River and Central Valley salmon and steelhead species was published in 2009. The plan identifies site specific actions necessary for species recovery and provides measurable criteria necessary for delisting the species. Priorities for the reintroduction of selected species are also identified. The recovery plan is not a regulatory document but serves as guidance for recovery efforts.

The plan identifies watersheds that have the physical and hydrological characteristics most likely to support viable fish populations and ranks the fish populations as Core 1, Core 2, and Core 3. Core 1 populations have the highest priority for recovery actions based on the potential of the watershed to support independent fish populations. For a fish population within a watershed to be considered Core 1, the population must meet population-level criteria for low risk of extinction. Core 2 populations are considered important to recovery in that they provide for diversity, spatial distribution, and abundance of the species. Core 3 populations are not expected to reach population levels beyond that considered to be at a high risk of extinction but still provide for increased genetic diversity.

Table SR-9 identifies each water body and NMFS priorities for recovery and/or species reintroduction.

PLACEHOLDER Table SR-9 NSF Recovery Priorities for Selected Water Bodies in Sacramento Valley

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

State Water Resources Control Board Instream Flow Studies

The Delta Reform Act of 2009 requires the SWRCB to complete instream flow studies for high priority rivers and streams by 2018. The flow studies are intended to be based on what would be needed if fishery protection was the sole purpose for which waters were put to beneficial use. The studies do not take other beneficial uses into account such as municipal and agricultural water supplies and recreational uses. The Board recognizes that establishing flow objectives is a multidimensional balancing effort and fishery protection represents only one of the factors (SWRCB 2010a). The following are identified for instream flow assessments:

- McCloud River
- Pit River
- Clear Creek
- Cottonwood Creek
- Antelope Creek
- Battle Creek
- Big Chico Creek
- Cow Creek
- Lower Butte Creek
- Mill Creek
- Deer Creek
- Lower Feather River
- American River
- Yuba River
- Bear River

Infrastructure

Freeport Regional Water Facility

The Freeport Regional Water Authority (FRWP) is a cooperative effort of the Sacramento County Water Agency (SCWA) and the East Bay Municipal Utility District (EBMUD) of Oakland to supply surface water from the Sacramento River to customers in central Sacramento County and the East Bay area of California. Construction of the FRWP facilities began in 2007 and became operational in Sacramento in 2011, with the completion of the Vineyard Surface Water Treatment Plant and supplies water to over 40,000 customers.

The diversion point and pumping facilities are located in the South part of Sacramento on the Sacramento River near the small community of Freeport. It provides SCWA with up to 85 million gallons of water per day (mgd) to supplement groundwater use in the central part of the county. EBMUD will use up to 100 mgd of this supply only during dry years, estimated to be three out of every 10 years, as a supplemental water source to complement existing conservation programs. EBMUD's facilities were also completed in 2011, but EBMUD will only use FRWP water during dry years. Water from the FRWP will serve 1.3 million customers in Alameda and Contra Costa counties.

Red Bluff Diversion Dam

The Red Bluff diversion dam was replaced by the Red Bluff Pumping Plant and Fish Screen Project in 2012. The diversion dam, completed in 1964, created a barrier to fish migration. The dam was originally equipped with fish ladders but the effectiveness of the ladders has always been an issue. With the completion of the pumping plant and fish screen, the new facility allows for unimpeded upstream and downstream passage for five runs of listed salmon and green sturgeon. The pumps provide up to 2,000 cfs (with the capacity to deliver 2,500 cfs with additional pumps) for the irrigation of 150,000 acres.

Governance

IRWM Planning

In 2011, the CABY region (Cosumnes, American, Bear, and Yuba) was awarded a Prop 84 planning grant to develop the IRWMP. CABY was awarded a total of $4.615 million from Prop 84 and Prop 1E for planning and implementation for a variety of projects including water meter installation, water conservation planning and habitat improvement.

In 2011, the Regional Water Authority of the American River Basin IRWM received $14.135 million in Prop 84 funding to update the IRWMP and to implement 17 integrated projects by various local agencies and organization in the region. The Authority completed the 2013 IRWMP update and developed a framework for the IRWM process.

The Yuba IRWM region recently received an IRWM planning grant to update their IRWM Plan. The update will include varied outreach to increase stakeholder involvement and coordination and is intended to comply with the IRWM Planning Act and DWR's 2012 IRWM Guidelines. The Plan Update is scheduled for completion and adoption by March 2015.

The Westside IRWM Group completed their IRWM Plan in June 2013 for managing water resources within Lake, Yolo, Napa, Solano, and a portion of Colusa counties through 2035. A formal agreement between the following five agencies established the Westside IRWM Group in 2010: Lake County Watershed Protection District; Napa County Flood Control and Water Conservation District; Solano County Water Agency; Water Resources Association of Yolo County; and Colusa County Resource Conservation District.

In 2011 the Northern Sacramento Valley region received a planning grant to manage water resources in Butte, Colusa, Glenn, Sutter, Tehama and a portion of Shasta County. This group was established by a 2010 MOU.

Flood

Mid & Upper Sacramento River Regional Planning

The Mid & Upper Sacramento River region of the CVFPP received a $1.2M grant in 2013 to improve local flood emergency plans, improve regional and interagency coordination during flood emergencies, develop standardized emergency responder and flood fight training. The region also received $2.16M planning grant in 2013 to describe current flood management conditions, opportunities for improving flood management, prioritization of potential projects, and development of a preliminary financing plan.

Watershed Planning and Restoration

Colusa County Watershed Management

Colusa County Resource Conservation District completed and released the Colusa Basin Watershed Management Plan in 2012. The Plan is a non-regulatory, community-driven guide which addresses the concerns of a variety of stakeholders. The document sets management goals, objectives, and achievable programs and projects to sustain and enhance watershed functions, including water supply and water quality.

The District also released the final report of the Colusa Basin Watershed Streambank Analysis in 2010. This report addresses water quality issues along tributaries in the Colusa Basin Watershed. The focus is on streambank erosion, invasive plant species, and riparian habitat.

The District released the Colusa Basin Watershed Assessment in 2008. The Assessment serves as a history and a current conditions report on watershed conditions, including water quality and water supply.

Battle Creek Restoration

Battle Creek restoration includes the installation of fish ladders and fish screens at three dams. Construction is expected to be completed in 2014. Other restoration actions include the removal of small dams on the South Fork Battle Creek, increasing flows from existing diversions, and hatchery releases. Once restoration actions are completed, 42 miles of additional habitat will be reestablished plus an additional 6 miles of habitat within area tributaries.

Water Supply

City of Davis and City of Woodland Planned Diversion

In September 2009, the Cities of Woodland and Davis established the Woodland-Davis Clean Water Agency (WDCWA), a joint powers authority, to implement and oversee a regional surface water supply project.

The regional project will replace deteriorating groundwater supplies with safe, more reliable surface water supplies from the Sacramento River. Once complete, the project will serve more than two-thirds of the urban population of Yolo County, CA. It will also serve UC Davis, a project partner. The project goals are to provide a new water supply to help meet existing and future needs, improve drinking water quality and improve the quality of treated wastewater.

The project plans include a jointly-owned and operated intake on the Sacramento River (WDCWA in partnership with RD 2035), raw water pipelines connecting the intake to a new regional water treatment plant, and separate pipelines delivering treated water to Woodland, Davis and UC Davis. Improvements to existing water supply systems will vary for Woodland and Davis and will include facilities such as distribution pipelines, water storage tanks and booster pump stations.

The project will divert up to 45,000 acre-feet of water per year from the Sacramento River. Water rights were granted in March 2011, and will be subject to conditions imposed by the state. Water diversions will be limited during summer and other dry periods. A more senior water right for 10,000 acre feet was purchased from the Conaway Preservation Group to provide summer water supply. Groundwater will continue to be used by Woodland and Davis during when demand for water cannot be met with surface water supplies alone.

The water treatment facility will be constructed to supply up to 30 million gallons of water per day, with an option for future expansion to 34 million gallons per day. Of that amount, Woodland's share of treated surface water will be 18 million gallons per day, with Davis' share at 12 million gallons per day. Approximately 5.1 miles of pipeline will transport "raw" water from the surface water intake on the Sacramento River to the water treatment plant located south of Woodland (see map). From there, the treated water will travel 7.8 miles via pipeline to Davis and up to 1.4 miles to Woodland. http://www.wdcwa.com/the_project

Local Groundwater Management

Since 2008, several agencies and communities have developed and adopted groundwater management plans for their region. Agencies responsible for the plans and year of adoption are listed below:

- Colusa County (2008)
- Sacramento Groundwater Authority (2008)
- Reclamation District No. 108 (2008)
- Natomas Central Mutual Water Company (2009)
- South Sutter Water District (2009)
- Yuba County Water Agency (2010)
- City of Vacaville (2011)
- City of Woodland (2011)
- Glenn County (2012)
- Reclamation District No. 1500 (2012)
- Sutter County Public Works Department (2012)
- Tehama County Flood Control Water Conservation District (2012)

~~Challenges~~

~~**This section is under development.**~~

Comment [FG30]: Delete?

Comment [ljm31]: Yes for now.

Looking to the Future

Future Conditions

Future Scenarios

For Update 2013, the Water Plan evaluates different ways of managing water in California depending on alternative future conditions and different regions of the state. The ultimate goal is to evaluate how different regional response packages, or combinations of resource management strategies from Volume 3, perform under alternative possible future conditions. The alternative future conditions are described as future scenarios. Together the response packages and future scenarios show what management options could provide for sustainability of resources and ways to manage uncertainty and risk at a regional level. The future scenarios are comprised of factors related to future population growth and factors related to future climate change. Growth factors for the Sacramento River region are described below. Climate change factors are described in general terms in Chapter 5, Volume 1.

PLACEHOLDER Box SR-7 Evaluation of Water Management Vulnerabilities – Sacramento River Region

PLACEHOLDER Box SR-7 Figure SR-A Range of Urban and Agricultural Reliability Results across Scenarios for the Sacramento River Region

PLACEHOLDER Box SR-7 Figure SR-B Range of Change in Groundwater Storage across Scenarios for the Sacramento River Region

PLACEHOLDER Box SR-7 Figure SR-C Range of Instream Flow Reliability across Scenarios for the Sacramento River Region

Water Conservation

The Water Plan scenario narratives include two types of water use conservation. The first is conservation that occurs without policy intervention (called background conservation). This includes upgrades in plumbing codes and end user actions such as purchases of new appliances and shifts to more water efficient landscape absent a specific government incentive. The second type of conservation expressed in the scenarios is through efficiency measures under continued implementation of existing best management practices in the Memorandum of Understanding (CUWCC 2004). These are specific measures that have been agreed upon by urban water users and are being implemented over time. Any other water conservation measures that require additional action on the part of water management agencies are not included in the scenarios, and would be represented as a water management response.

Sacramento River Growth Scenarios

Future water demand in the Sacramento River hydrologic region is affected by a number of growth and land use factors, such as population growth, planting decisions by farmers, and size and type of urban landscapes. See Table SR-10 for a conceptual description of the growth scenarios used in the CWP. The CWP quantifies several factors that together provide a description of future growth and how growth could affect water demand for the urban, agricultural, and environmental sectors in the Sacramento River region. Growth factors are varied between the scenarios to describe some of the uncertainty faced by water managers. For example, it is impossible to predict future population growth accurately, so the CWP uses three different but plausible population growth estimates when determining future urban water demands. In addition, the CWP considers up to three different alternative views of future development density. Population growth and development density will reflect how large the urban landscape will become in 2050 and are used by the CWP to quantify encroachment into agricultural lands by 2050 in the Sacramento River region.

PLACEHOLDER Table SR-10 Conceptual Growth Scenarios

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

For Update 2013, DWR worked with researchers at the University of California, Davis, to quantify how much growth might occur in the Sacramento River region through 2050. The UPlan model was used to estimate a year 2050 urban footprint under the scenarios of alternative population growth and development density (see http://ice.ucdavis.edu/project/uplan for information on the UPlan model). UPlan is a simple rule-based urban growth model intended for regional or county-level modeling. The needed space for each land use type is calculated from simple demographics and is assigned based on the net attractiveness of locations to that land use (based on user input), locations unsuitable for any development, and a general plan that determines where specific types of development are permitted. Table SR-11 describes the amount of land devoted to urban use for 2006 and 2050, and the change in the urban footprint under each scenario. As shown in the table, the urban footprint grew by about 125 thousand acre under low population growth scenario (LOP) by 2050 relative to 2006 base-year footprint of about 700 thousand acres. Urban footprint under high population scenario (HIP), however, grew by about 355 thousand acres. The effect of varying housing density on the urban footprint is also shown.

PLACEHOLDER Table SR-11 Growth Scenarios (Urban) – Sacramento River

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Table SR-12 describes how future urban growth could affect the land devoted to agriculture in 2050. Irrigated land area is the total agricultural footprint. Irrigated crop area is the cumulative area of agriculture, including multi-crop area, where more than one crop is planted and harvested each year. Each of the growth scenarios shows a decline in irrigated acreage over existing conditions, but to varying degrees. As shown in the table, irrigated crop acreage declines by about 10 thousand acres by year 2050 as a result of low population growth and urbanization in the Sacramento River region, while the decline under high population growth was higher by about 70 thousand acres.

PLACEHOLDER Table SR-12 Growth Scenarios (Agriculture) – Sacramento River

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Sacramento River 2050 Water Demands

In this section a description is provided for how future water demands might change under scenarios organized around themes of growth and climate change described earlier in this chapter. The change in water demand from 2006 to 2050 is estimated for the Sacramento River region for the agriculture and urban sectors under nine growth scenarios and 13 scenarios of future climate change. The climate change scenarios included the 12 CAT scenarios described in Chapter 5, Volume 1 and a 13th scenario representing a repeat of the historical climate (1962-2006) to evaluate a “without climate change” condition.

Figure SR-7 shows the change in water demands for the urban and agricultural sectors under nine growth scenarios, with variation shown across 13 climate scenarios. The nine growth scenarios include three alternative population growth projections and three alternative urban land development densities, as shown in Table SR-10. The change in water demand is the difference between the historical average for 1998 to 2005 and future average for 2043 to 2050. Urban demand is the sum of indoor and outdoor water demand where indoor demand is assumed not to be affected by climate. Outdoor demand, however, depends on such climate factors as the amount of precipitation falling and the average air temperature. The solid blue dot in Figure SR-7 represents the change in water demand under a repeat of historical climate, while the open circles represent change in water demand under 12 scenarios of future climate change.

PLACEHOLDER Figure SR-7 Change in Sacramento River Agricultural and Urban Demands for 117 Scenarios from 2006-2050 (thousand acre-feet per year)

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Urban demand increased under all 9 growth scenarios tracking with population growth. On average, it increased by about 290 thousand acre-feet under the three low population scenarios, 500 thousand acre-feet under the three current trend population scenarios and about 820 thousand acre-feet under the three high population scenarios when compared to historical average of about 840 thousands-acre-feet. The results show change in future urban water demands are less sensitive to housing density assumptions or climate change than to assumptions about future population growth.

Agricultural water demand decreases under all growth scenarios when only considering a repeat of historical climate, primarily due to a reduction in irrigated lands as a result of urbanization and additional water savings from background water conservation. However, when considering the potential effects of future climate change many scenarios show an increase in agricultural water demand even when there is a reduction in irrigated crop area as shown in Table SR-3X. Under high population scenarios the decrease was about 50 thousand acre-feet, but under the three low and current trend population scenarios, the average increase in water demand was about 110 thousand acre-feet and 200 thousand acre-feet, respectively, when compared with historical average of 7490 thousand acre-feet. The results show that low density housing would result in more reduction in agricultural demand since more lands are lost under low-density housing than high density housing.

Integrated Water Management Plan Summaries

Inclusion of the information contained in IRWMP's into the CWP Regional Reports has been a common suggestion by regional stakeholders at the Regional outreach meetings since the inception of the IRWM program. To this end the California Water Plan has taken on the task of summarizing readily available Integrated Water Management Plan in a consistent format for each of the regional reports. This collection of information will not be used to determine IRWM grant eligibility. This effort is ongoing and will be included in the final CWP updates and will include up to 4 pages for each IRWMP in the regional reports.

In addition to these summaries being used in the regional reports we intend to provide all of the summary sheets in one IRWMP Summary "Atlas" as an article included in Volume 4. This atlas will, under one cover, provide an "at-a-glance" understanding of each IRWM region and highlight each region's key water management accomplishments and challenges. The atlas will showcase how the dedicated efforts of individual regional water management groups (RWMGs) have individually and cumulatively transformed water management in California.

All IRWMP's are different in how are organized and therefore finding and summarizing the content in a consistent way proved difficult. It became clear through these efforts that a process is needed to allow those with the most knowledge of the IRWMP's, those that were involved in the preparation, to have input on the summary. It is the intention that this process be initiated following release of the CWP Update 2013 and will continue to be part of the process of the update process for Update 2018. This process will also allow for continuous updating of the content of the atlas as new IRWMP's are released or existing IRWMP's are updated.

As can be seen in Figure SR-8 there are 8 IRWM planning efforts ongoing in the Sacramento River Hydrologic Region.

PLACEHOLDER Figure SR-8 Integrated Water Management Planning in the Sacramento River Region

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

Placeholder Text: At the time of the Public Review Draft the collection of information out of the IRWMP's in the region has not been completed. Below are the basic types of information this effort will summarize and present in the final regional report for each IRWMP available. An opportunity will be provided to those with responsibility over the IRWMP to review these summaries before the reports are final.

Region Description: This section will provide a basic description of the IRWM region. This would include location, major watersheds within the region, status of planning activity, and the governance of the IRWM. In addition, a IRWM grant funding summary will be provided.

Key Challenges: The top five challenges identified by the IRWM would be listed in this section.

Principal Goals/Objective: The top five goals and objectives identified in the IRWMP will be listed in this section.

Major IRWM Milestones and Achievements: Major milestones (Top 5) and achievements identified in the IRWMP would be listed in this section.

Water Supply and Demand: A description (one paragraph) of the mix of water supply relied upon in the region along with the current and future water demands contained in the IRWMP will be provided in this section.

Flood Management: A short (one paragraph) description of the challenges faced by the region and any actions identified by the IRWMP will be provided in this section.

Water Quality: A general characterization of the water quality challenges (one paragraph) will be provided in this section. Any identified actions in the IRWMP will also be listed.

Groundwater Management: The extent and management of groundwater (one paragraph) as described in the IRWMP will be contained in this section.

Environmental Stewardship: Environmental stewardship efforts identified in the IRWMP will be summarized (one paragraph) in this section.

Climate Change: Vulnerabilities to climate change identified in the IRWMP will be summarized (one paragraph) in this section.

Tribal Communities: Involvement with tribal communities in the IRWM will be described (one paragraph) in this section of each IRWMP summary.

Disadvantaged Communities: A summary (one paragraph) of the discussions on disadvantaged communities contained in the IRWMP will be included in this section of each IRWMP summary.

Governance: This section will include a description (less than one paragraph) of the type of governance the IRWM is organized under.

Resource Management Strategies

Volume 3 contains detailed information on the various strategies which can be used by water managers to meet their goals and objectives. A review of the resource management strategies addressed in the available IRWMP's are summarized in Table SR-13.

PLACEHOLDER Table SR-13 Resource Management Strategies addressed in IRWMP's in the Sacramento River Hydrologic Region

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Climate Change

For over two decades, the State and federal governments have been preparing for climate change effects on natural and built systems with a strong emphasis on water supply. Climate change is already impacting many resource sectors in California, including water, transportation and energy infrastructure, public health, biodiversity, and agriculture (USGCRP, 2009; CNRA, 2009). Climate model simulations based on the Intergovernmental Panel on Climate Change's 21st century scenarios project increasing temperatures in California, with greater increases in the summer. Projected changes in annual precipitation patterns in California will result in changes to surface runoff timing, volume, and type (Cayan, 2008). Recently developed computer downscaling techniques indicate that California flood risks from warm-wet, atmospheric river type storms may increase beyond those that we have known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (Dettinger, 2011).

Currently, enough data exists to warrant the importance of contingency plans, mitigation (reduction) of greenhouse gas (GHG) emissions, and incorporating adaptation strategies; methodologies and infrastructure improvements that benefit the region at present and into the future. While the State is taking aggressive action to mitigate climate change through GHG reduction and other measures (CARB, 2008), global impacts from carbon dioxide and other GHGs that are already in the atmosphere will continue to impact climate through the rest of the century (IPCC, 2007).

Resilience to an uncertain future can be achieved by implementing adaptation measures sooner rather than later. Because of the economic, geographical, and biological diversity of California, vulnerabilities and risks from current and future anticipated changes are best assessed on a regional basis. Many resources are available to assist water managers and others in evaluating their region-specific vulnerabilities and identifying appropriate adaptive actions. (EPA/DWR, 2011; Cal-EMA/CNRA, 2012).

Observations

Due to the region's large size, complex topography, and multiple climate zones, temperature and precipitation trends have considerable variation. Over the past century, air temperatures measured throughout the region indicate a general warming trend. Regionally-specific air temperature data was retrieved through the Western Regional Climate Center (WRCC). The WRCC has temperature and precipitation data for the past century. Through an analysis of National Weather Service Cooperative Station and PRISM Climate Group gridded data, scientists from the WRCC have identified 11 distinct regions across the state for which stations located within a region vary with one another in a similar fashion. These 11 climate regions are used when describing climate trends within the state (Abatzoglou et al. 2009). DWR's hydrologic regions, however, do not correspond directly to WRCC's climate regions. A particular hydrologic region may overlap more than one climate region and, hence, have different climate trends in different areas. For the purpose of this regional report, climate trends of the major overlapping climate regions are considered to be relevant trends for respective portions of the overlapping hydrologic region.

Locally in the Sacramento River region, within the WRCC North Central climate region, mean temperatures have increased by about 0.5 to 2.8 °F (0.3 to 1.6 °C) in the past century, with minimum and maximum temperatures increasing by about 1.2 to 2.1 °F (0.6 to 1.2 °C) and 0.1 to 1.4 °F (0.05 to 0.8 °C), respectively. Within the WRCC North East climate region, mean temperatures have increased by about 0.8 to 2.0 °F (0.5 to 1.1 °C) in the past century, with minimum and maximum temperatures increasing by about 0.9 to 2.2 °F (0.5 to 1.2 °C) and by 0.4 to 2.1 °F (0.2 to 1.2 °C), respectively. Within the WRCC Sierra climate region, mean temperatures have increased by about 0.8 to 1.9 °F (0.4 to 1.1 °C) in the past century, with minimum and maximum temperatures increasing and decreasing by about 1.7 to 2.7 °F (0.9 to 1.5 °C) and by -0.3 to 1.3 °F (-0.2 to 0.7 °C), respectively. Within the WRCC Sacramento-Delta climate region, mean temperatures have increased by about 1.5 to 2.4 °F (0.8 to 1.3 °C) in the past century, with minimum and maximum temperatures increasing by about 2.1 to 3.1 °F (1.2 to 1.7 °C) and by 0.7 to 1.9 °F (0.4 to 1.1 °C), respectively (WRCC, 2012).

Over the past century, the mean sea level at the San Francisco tide gage near the Golden Gate Bridge has risen approximately seven inches. Mean annual precipitation in Northern California has increased slightly in the 20th century, and precipitation patterns in the region have considerable geographic and annual variation (DWR, 2006). A hydrologic and climate sensitivity analysis in the Upper Feather River Watershed by Huang et al (2012) indicated that historical air temperature and seasonal streamflow had statistically significant trends, suggesting that warmer air temperatures are causing snowmelt runoff to occur earlier in the water year.

Projections and Impacts

While historic data is a measured indicator of how the climate is changing, it can't project what future conditions may be like under different GHG emissions scenarios. Current climate science uses modeling methods to simulate and develop future climate projections. A recent study by Scripps Institution of Oceanography uses the most sophisticated methodology to date, and indicates by 2060-2069, temperatures will be 3.4to 4.9oF (1.9 to 2.7oC) higher across the state than they were from 1985 to1994 (Pierce et al, 2012). Annual mean temperatures by 2060-69 are projected to increase by 4.0 °F (2.2 °C) for the WRCC North Central climate region, with increases of 3.1 °F (1.7 °C) during the winter months and 5.2 °F (2.9 °C) during summer. The WRCC North East climate region has similar projections with annual mean temperatures increasing by 4.7 °F (2.6 °C), winter temperatures increasing by 3.4 °F (1.9

°C), and summer temperatures increasing by 6.5°F (3.6 °C). The WRCC Sierra climate region projections have annual mean temperatures increasing by 4.5 °F (2.5 °C), winter temperatures increasing by 3.4 °F (1.9 °C), and summer temperatures increasing by 5.9°F (3.3 °C). The WRCC Sacramento-Delta climate region projections have annual mean temperatures increasing by 4.1 °F (2.3 °C), winter temperatures increasing by 3.1 °F (1.7 °C), and summer temperatures increasing by 5.2 °F (2.9 °C). Climate projections for this region, from Cal-Adapt indicate that temperatures between 1990 and 2100 will increase by 8 °F (4.4 °C) in the winter and 12 °F (6.7 °C) in the summer (Cal-EMA and CNRA, 2012).

Changes in annual precipitation across California, either in timing or total amount, will result in changes in type of precipitation (rain or snow) in a given area, and in surface runoff timing and volume. Most climate model precipitation projections for the State anticipate drier conditions in southern California, with heavier and warmer winter precipitation in northern California. Warmer temperatures will result in more precipitation falling as rain instead of snow, decreased snowpack, and increased wildfire risk (Cal-EMA/CNRA, 2012). Modeling results by Huang et al (2012) suggest the Upper Feather River Watershed April 1st snowpack would be diminished by 63 percent with 3.6°F (2°C) of warming; all modeled climate scenario projections from this study lead to a negative impact on water supply.

More intense wet and dry periods are anticipated, which could lead to flooding in some years and drought in others. In addition, extreme precipitation events are projected to increase with climate change (Pierce, et al., 2012). Recent computer downscaling techniques indicate that California flood risks from warm-wet, atmospheric river type storms may increase beyond those that we have known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (Dettinger, 2011). Winter runoff could result in flashier flood hazards. . A higher proportion of precipitation falling as rain instead of snow and increased storm frequency will impact the system's ability to provide effective flood protection. Since there is less scientific detail on localized precipitation changes, there exists a need to adapt to this uncertainty at the regional level (Qian, Y., et al, 2010).

A recent study that explores future climate change and flood risk in the Sierras, using downscaled simulations (refining computer projections to a scale smaller than global models) from three global climate models (GCMs) under an accelerating GHG emissions scenario that is more reflective of current trends, indicates a tendency toward increased three-day flood magnitude. By the end of the 21st century, all three projections yield larger floods for both the moderate elevation northern Sierra Nevada watershed and for the high elevation southern Sierra Nevada watershed, even for GCM simulations with 8 to15 percent declines in overall precipitation. The increases in flood magnitude are statistically significant for all three GCMs for the period 2051 to 2099. By the end of the 21st Century, the magnitudes of the largest floods increase to 110 to 150 percent of historical magnitudes. These increases appear to derive jointly from increases in heavy precipitation amount, storm frequencies, and days with more precipitation falling as rain and less as snow (Das, et al., 2011)

The Sierra Nevada snowpack, is expected to continue to decline as warmer temperatures raise the elevation of snow levels, reduce spring snowmelt, and increase winter runoff. Based upon historical data and modeling, researchers at Scripps Institution of Oceanography project that by the end of this century the Sierra snowpack will experience a 48 to 65 percent loss from its average at the end of the previous century (van Vuuren et al., 2011). In addition, earlier seasonal flows will reduce the flexibility in how the state manages its reservoirs to protect communities from flooding while ensuring a reliable water supply.

Additionally, sea level is projected to continue to rise along California's coast. For the California coast south of Cape Mendocino, the National Research Council projected that sea level will rise 1.5 to 12 inches (3.8 to 30 cm) by 2030, 4.5 to 24 inches (11.4 to 61 cm) by 2050, and 16.5 to 66 inches (41.9 to 168 cm) by 2100 ((National Research Council [NRC], 2012)). Although the Sacramento River region has no coastline borders, its boundaries extend through the Delta to Chipps Island where waters are influenced by tidal fluctuations and sea level rise.

Warmer waters will result in stress to fisheries, a reduction of coldwater habitat for species of concern, and negatively impact restoration efforts. Thompson et al. (2011) concluded that long-term survival of Spring-run Chinook salmon in Butte Creek (a significant tributary to the Sacramento River) is unlikely under climate change projections and simple changes to water operations are not likely to decrease vulnerabilities to warmer temperatures. With higher summer air temperatures on land, the northern and eastern portions of the region will be at higher risk of wildfire, some having 4 times more risk than current levels by the end of the century (Cal-EMA/CNRA, 2012).

Adaptation

Climate change has the potential to impact the region, which the State depends upon for its vast economic and environmental benefits. These changes will increase the vulnerability of water resources infrastructure including flood control, water supply, and wastewater treatment and disposal. Changes will challenge current operational procedures for the CVP and the SWP, and impact the natural environment by further stressing ecosystems and protective processes. The loss of natural snowpack storage and runoff timing will impact water supply, making the region more dependent on surface storage in reservoirs and groundwater sources. Increased future water demand for both ecological processes and agriculture may be particularly challenging with less natural storage and less overall supply.

Water managers and local agencies must work together determine the appropriate planning approach for their operations and communities. While climate change adds another layer of uncertainty to water planning, it does not fundamentally alter the way water managers already address uncertainty (EPA/DWR, 2011). However, stationarity (the idea that natural systems fluctuate within an unchanging envelope of variability) can no longer be assumed, so new approaches will likely be required (Milly et al., 2008).

Local agencies, as well as federal and state agencies, face the challenge of interpreting new climate change data and information and determining which adaptation methods and approaches are appropriate for their planning needs. The Climate Change Handbook for Regional Water Planning (EPA/DWR, 2011) provides an analytical framework for incorporating climate change impacts into the regional and watershed planning process and considers adaptation to climate change. This handbook provides guidance for assessing the vulnerabilities of California's watersheds and hydrologic regions to climate change impacts, and prioritizing these vulnerabilities.

Integrated Regional Water Management (IRWM) planning is a framework that allows water managers to address climate change on a smaller, more regional scale. Climate change is now a required component of all IRWM plans (DWR 2010). IRWM regions must identify and prioritize their specific vulnerabilities, and identify adaptation strategies that are most appropriate for their sub-regions. Planning strategies to address vulnerabilities and adaptation to climate change should be both proactive and adaptive, starting with strategies that benefit the region in the present-day while adding future flexibility and resilience under uncertainty.

CVP and SWP operations within the region are particularly sensitive to precipitation, reservoir carryover storage levels, demand, and Delta exports. Surface Storage- CALFED is a Resource Management Strategy outlined in Water Plan that would benefit the CVP and SWP under climate change. Additional reservoir storage would allow greater management flexibility to capture runoff as it occurs and act as a buffer between wet and dry periods. Operations can also be modified as a strategy to improve downstream flood protection while minimizing impacts to water storage in upstream reservoirs. Integrated Flood Management is a Resource Management Strategy employed by DWR in the Yuba-Feather River system. DWR has developed the Forecast-Coordinated Operations Program to reduce downstream peak flows and maintain maximum reservoir capacities through improved forecasting and enhanced communication between local, state, and federal agencies.

Additional resource management strategies found in the Water Plan not only assist in meeting water management objectives, but also provide benefits for adapting to climate change in the region. These include:

- Conveyance – Regional/local
- System Reoperation
- Conjunctive Management and Groundwater storage
- Precipitation Enhancement
- Surface Storage – Regional/Local
- Pollution Prevention
- Ecosystem Restoration
- Forest Management
- Land Use Planning and Management
- Recharge Area Protection
- Watershed Management

The myriad of resources and choices available to managers can seem overwhelming, and the need to take action given uncertain future conditions is daunting. However, there are many actions that water managers can take to prepare for climate change, regardless of the magnitude of future warming. These actions often provide economic and public health co-benefits. Water and energy conservation are examples of strategies that make sense with or without the additional pressures of climate change. Conjunctive management projects that manage surface and groundwater in a coordinated fashion could provide a buffer against variable annual water supplies. Forecast-coordinated operations would provide flexibility for water managers to respond to weather conditions as they unfold.

Water managers will need to consider both the natural and built environments as they plan for the future. Stewardship of natural areas and protection of biodiversity are critical for maintaining ecosystem services important for human society such as carbon sequestration, pollution remediation, and habitat for pollinators. Increased cross-sector collaboration between water managers, land use planners and ecosystem managers provides opportunities for identifying common goals and actions needed to achieve resilience to climate change and other stressors.

Mitigation

California’s water sector has a large energy footprint, consuming 7.7% of statewide electricity (CPUC, 2010). Energy is used in the water sector to extract, convey, treat, distribute, use, condition, and dispose of water. Figure 3-26, Water-Energy Connection in Volume 1, CA Water Today shows all of the connections between water and energy in the water sector; both water use for energy generation and energy use for water supply activities. The regional reports in the 2013 California Water Plan Update are the first to provide detailed information on the water-energy connection, including energy intensity (EI) information at the regional level. This EI information is designed to help inform the public and water utility managers about the relative energy requirements of the major water supplies used to meet deman. Since energy usage is related to Greenhouse Gas (GHG) emissions, this information can support measures to reduce GHG's, as mandated by the State.

Figure SR-8 shows the amount of energy associated with the extraction and conveyance of 1 acre-foot of water for each of the major sources in this region. The quantity used is also included, as a percent. For reference, Figure 3-26, Water-Energy Connection in CA Water Today, Volume 1 highlights which water-energy connections are illustrated in Figure SR-8; only extraction and conveyance of raw water. Energy required for water treatment, distribution, and end uses of the water are not included. Not all water types are available in this region. Some water types flow by gravity to the delivery location and therefore do not require any energy to extract or convey (represented by a white light bulb).

Recycled water and water from desalination used within the region are not show in Figure SR-8 because their energy intensity differs in important ways from those water sources. The energy intensity of both recycled and desalinated water depend not on regional factors but rather on much more localized, site, and application specific factors. Additionally, the water produced from recycling and desalination is typically of much higher quality than the raw (untreated) water supplies evaluated in Figure SR-8. For these reasons, discussion of energy intensity of desalinated water and recycled water are included in Volume 3, Resource Management Strategies.

Energy intensity, sometimes also known as embedded energy, is the amount of energy needed to extract and convey (Extraction refers to the process of moving water from its source to the ground surface. Many water sources are already at ground surface and require no energy for extraction, while others like groundwater or sea water for desalination require energy to move the water to the surface. Conveyance refers to the process of moving water from a location at the ground surface to a different location, typically but not always a water treatment facility. Conveyance can include pumping of water up hills and mountains or can occur by gravity) an acre-foot of water from its source (e.g. groundwater or a river) to a delivery location, such as a water treatment plant or a State Water Project (SWP) delivery turnout (Energy from low-head pump lifts (less than 50 feet) used to divert water out of river channels or canals has been excluded from the calculations). Energy intensity should not be confused with total energy—that is, the amount of energy (e.g. kWh) required to deliver all of the water from a water source to customers within the region. Energy intensity focuses not on the total amount of energy used to deliver water, but rather the energy required to deliver a single unit of water (in kWh/acre-foot). In this way, energy intensity gives a normalized metric which can be used to compare alternative water sources.

In most cases, this information will not be of sufficient detail for actual project level analysis. However, these generalized, region-specific metrics provide a range in which energy requirements fall. The information can also be used in more detailed evaluations using tools such as WeSim (http://www.pacinst.org/publication/wesim/) which allows modeling of water systems to simulate outcomes for energy, emissions, and other aspects of water supply selection. It's important to note that water supply planning must take into consideration a myriad of different factors in addition to energy impacts; costs, water quality, opportunity costs, environmental impacts, reliability and other many other factors.

Energy intensity is closely related to Greenhouse Gas (GHG) emissions, but not identical, depending on the type of energy used (see CA Water Today, Water-Energy, Volume 1). In California, generation of 1 megawatt-hour (MWh) of electricity results in the emission of about 1/3 of a metric ton of GHG, typically referred to as carbon dioxide equivalent or CO2e (eGrid, 2012). This estimate takes into account the use of GHG-free hydroelectricity, wind, and solar and fossil fuel sources like natural gas and coal. The GHG emissions from a specific electricity source may be higher or lower than this estimate.

Reducing GHG emissions is a State mandate. Water managers can support this effort by considering energy intensity factors, such as those presented here, in their decision making process. Water use efficiency and related best management practices can also reduce GHGs (See Volume 2, Resource Management Strategies).

Accounting for Hydroelectric Energy

Generation of hydroelectricity is an integral part of many of the state's large water projects. In 2007, hydroelectric generation accounted for nearly 15% of all electricity generation in Californi a. The State Water Project, Central Valley Project, Los Angeles Aqueduct, Mokelumne Aqueduct, and Hetch Hetchy Aqueducts all generate large amounts of hydroelectricity at large multi-purpose reservoirs at the heads of each system. In addition to hydroelectricity generation at head reservoirs, several of these systems also generate hydroelectric energy by capturing the power of water falling through pipelines at in-conduit generating facilities (In-conduit generating facilities refer to hydroelectric turbines that are placed along pipelines to capture energy as water runs downhill in a pipeline (conduit)). Hydroelectricity is also generated at hundreds of smaller reservoirs and run-of-the-river turbine facilities.

Hydroelectric generating facilities at reservoirs provide unique benefits. Reservoirs like the State Water Project's Oroville Reservoir are operated to build up water storage at night when demand for electricity is low, and release the water during the day time hours when demand for electricity is high. This operation, common to many of the state's hydropower reservoirs, helps improve energy grid stabilization and reliability and reduces GHG emissions by displacing the least efficient electricity generating facilities. Hydroelectric facilities are also extremely effective for providing back-up power supplies for intermittent renewable resources like solar and wind power. Because the sun can unexpectedly go behind a cloud or the wind can die down, intermittent renewables need back up power sources that can quickly ramp up or ramp down depending on grid demands and generation at renewable power installations.

Despite these unique benefits and the fact that hydroelectric generation was a key component in the formulation and approval of many of California's water systems, accounting for hydroelectric generation in energy intensity calculations is complex. In some systems like the SWP and CVP, water generates electricity and then flows back into the natural river channel after passing through the turbines. In other systems like the Mokelumne aqueduct water can leave the reservoir by two distinct out flows, one that generates electricity and flows back into the natural river channel and one that does not generate electricity and flows into a pipeline flowing into the East Bay Municipal Utility District service area. In both these situations, experts have argued that hydroelectricity should be excluded from energy intensity calculations because the energy generation system and the water delivery system are in essence separate

(Wilkinson, 2000).

DWR has adopted this convention for the energy intensity for hydropower in the regional reports. All hydroelectric generation at head reservoirs has been excluded from Figure SR-8. Consistent with Wilkinson (2000) and others, DWR has included in-conduit and other hydroelectric generation that occurs as a consequence of water deliveries, such as the Los Angeles Aqueduct's hydroelectric generation at San Francisquito, San Fernando, Foothill and other power plants on the system (downstream of the Owen's River Diversion Gates). DWR has made one modification to this methodology to simplify the display of results: energy intensity has been calculated at each main delivery point in the systems; if the hydroelectric generation in the conveyance system exceeds the energy needed for extraction and conveyance, the energy intensity is reported as zero (0). I.e., no water system is reported as a net producer of electricity, even though several systems do produce more electricity in the conveyance system than is used (e.g., Los Angeles Aqueduct, Hetch Hetchy Aqueduct). (For detailed descriptions of the methodology used for the water types presented, see Technical Guide, Volume 5).

PLACEHOLDER Figure SR-8 Energy Intensity of Raw Water Extraction and Conveyance in the Sacramento Hydrologic Region

[Any draft tables, figures, and boxes that accompany this text for the public review draft are included at the end of the report.]

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